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ART. XVII.—*Obituary Notices of Brown and Humboldt, Members of the American Academy of Arts and Sciences;* from the Report of the Council of the Academy for 1859.

(Proceedings of the Academy, vol. iv, p. 229 et seq.)

BEYOND the immediate pale of science, and the circle of its most devoted cultivators, the association of the names of HUMBOLDT and BROWN may seem new and strange;—the one, a name familiar to the whole civilized world; the other, hardly known to a large portion of his educated countrymen. Yet these names stand together, in the highest place, upon the rolls of almost every Academy of Science in the world; and the common judgment of those competent to pronounce it will undoubtedly be, that although these vacant places upon those honorable rolls may be occupied, they will not be *filled*, in this, perhaps not in several generations.

Upon the death of ROBERT BROWN, which occurred on the 10th of June last, in his eighty-fifth year, it was remarked that, next to Humboldt, his name adorned the honorary list of a greater number of scientific societies than that of any other naturalist or philosopher. It was Humboldt himself who, many years ago, saluted Brown with the appellation of *Botanicarum facile Princeps;* and the universal consent of botanists recognized and confirmed the title. However the meed of merit in science should be divided between the most profound, and the most active and prolific minds,—between those who *divine* and those

who *elaborate*,—it will probably be conceded by all, that no one since Linnæus has brought such rare sagacity to bear upon the structure, and especially upon the ordinal characters and natural affinities of plants, as did Robert Brown. True, he was fortunate in his time and his opportunities. Men of great genius, happily, often are, or appear to be, through their power of turning opportunities to good account. The whole herbaria of Sir Joseph Banks, and the great collections which he himself made around the coast of Australia, in Flinder's expedition, and which he was able to investigate upon the spot during the four years devoted to this exploration, opportunely placed in Brown's able hands as it were the vegetation of a new world, as rich as it was peculiar,—just at the time, too, when the immortal work of Jussieu had begun to be appreciated, and the European and other ordinary forms of vegetation had begun to be understood in their natural relations. The new, various, and singular types which render the botany of New Holland so unlike all other, Mr. Brown had to compare among themselves,—to unravel their intricacies with scarcely a clew to guide him, except that which his own genius enabled him to construct in the process of the research,—and to bring them harmoniously into the general system of botanical natural alliance as then understood, and as he was himself enabled to ascertain and display it. It was the wonderful sagacity and insight which he evinced in these investigations, which, soon after his return from Australia, revealed the master mind in botanical science, and erelong gave him the position of almost unchallenged eminence, which he retained, as if without effort, for more than half a century.

The common observer must wonder at this general recognition, during an era of great names and unequalled activity, of a claim so rarely, and as it were so reluctantly, asserted. For brief and comparatively few—alas! how much fewer than they should have been!—are Mr. Brown's publications. Much the largest of them is the Prodromus of the Flora of New Holland, issued fifty years ago, which begins upon the one hundred and forty-fifth page, and which stopped short at the end of the first volume. The others are special papers, mostly of small bulk, devoted to the consideration of a particular plant, or a particular group or small collection of plants. But their simple titles seldom foreshow the full import of their contents. Brown delighted to rise from a special case to high and wide generalizations; and was apt to draw most important and always irresistible conclusions from some small, selected data, or particular point of structure, which to ordinary apprehension would appear wholly inadequate to the purpose. He had unequalled skill in finding decisive instances. So all his discoveries, so simply and quietly announced, and all his notes and observations, sedulously

reduced to the briefest expression, are fertile far beyond the reader's expectation. Cautious to excess, never suggesting a theory until he had thoroughly weighed all the available objections to it, and never propounding a view which he did not know how to prove, perhaps no naturalist ever taught so much in writing so little, or made so few statements that had to be recalled, or even recast; and of no one can there be a stronger regret that he did not publish more.

With this character of mind, and while carefully sounding his way along the deep places of a science the philosophy and grounds of which were forming, day by day, under his own and a few contemporary hands, Brown could not have been a voluminous writer. He could never have undertaken a *Systema Regni Vegetabilis*, content to do his best at the moment, and to take upon trust what he had not the means or the time to verify,—like his contemporary, DeCandolle who may worthily be compared with Brown for genius, and contrasted with him for the enthusiastic devotion which constantly impelled him to publication, and to lifelong, unselected, herculean labor, over all the field, for the general good.

Nor could Brown ever be brought to undertake a *Genera Plantarum*, like that of Jussieu; although his favorable and leisurely position, his vast knowledge, his keen discrimination, and his most compact mode of expression, especially indicated him for the task. Evidently, his influence upon the progress of Botany might have been greater, or at least more immediate and more conspicuous. Yet, rightly to estimate that influence now, we have only to compare the *Genera Plantarum* of Endlicher with that of Jussieu,—separated as they are by the half-century which coincided with Brown's career,—and mark how largely the points of difference between the two, so far as they represent inquiry, and genuine advancement in the knowledge of floral structure, actually originated with him. Still, after making due allowance for a mind as scrupulous and cautious as it was clear and profound, also for an unusually retiring disposition, which even in authorship seems to have rendered him as sedulous to avoid publicity as most writers are to gain it, it must be acknowledged that his retentiveness was excessive; and that his guarded published statements sometimes appear as if intended—like the anagrams of the older mathematicians and philosophers—rather to record his knowledge than to reveal it. But this was probably only in appearance, and rather to be attributed to his sensitive regard for entire accuracy, and his extreme dislike of all parade of knowledge,—to the same peculiarity which everywhere led him to condense announcements of great consequence into short paragraphs or foot-notes, and to insert the most important facts in parentheses, which he who runs over the page may read, indeed,

but which only the most learned and the most reflecting will be apt to comprehend. In candor it must be said, that his long career has left some room for the complaint that he did not feel bound to exert fully and continuously all his matchless gifts in behalf of the science of which he was the most authoritative expositor.

But if thus in some sense unjust to himself and to his high calling, Brown could never be charged with the slightest injustice to any fellow-laborer. He was scrupulously careful, even solicitous, of the rights and claims of others; and in tracing the history of any discovery in which he had himself borne a part, he was sure to award to each one concerned his full due. If not always communicative, he was kind and considerate to all. To adopt the words of one of his intimate associates, "those who knew him as a man will bear unanimous testimony to the unvarying simplicity, truthfulness, and benevolence of his character," as well as to "the singular uprightness of his judgment."

The remaining, and the most illustrious name of all,—and one in its wide renown strongly in contrast with the last,—has only just now been inscribed upon our obituary list.

The telegraph of the last week brought to us the painful intelligence that the patriarch of science, the universal HUMBOLDT, died at Berlin on the 6th of May. Born in 1769, a year more prolific in great men than any equal period of all preceding time,* Humboldt had, before the end of the eighteenth century, exhibited qualities of the very highest order, and obtained a place of acknowledged celebrity in Europe. This, however, was the mere prelude to his career, for with the close of that century he commenced, with Bonpland, his wonderful exploration of Spanish America, which continued during five years. This journey must be considered in all future time as, substantially, the scientific discovery of Spanish America; and whether we measure its results by the amount of knowledge through the wide fields of Astronomy, Geography, Geology, Mineralogy, Meteorology, Zoology, Botany, and Political Economy, or the personal qualities by which this knowledge was collected and reduced to its place in the records of science, we cannot hesitate to rank the expedition amongst the most important and successful ever executed by man.

On his return to Europe, in 1805, Humboldt was employed several years in reducing his immense collection of materials to form for publication. From that time to his death, a period of almost half a century, he resided (except for a short time, in

* Napoleon, Wellington, Mehemet Ali, Soult, Lannes, Ney, Castlereagh, Chateaubriand, Cuvier, and Humboldt. [The name of Metternich is sometimes added to this list, probably incorrectly. That of Canning certainly does not belong here, nor that of Mackintosh, nor of Sir Walter Scott.—EDS.]

which he made his journey to Northern Asia) in Europe, mostly in France and Germany. The last twelve or fifteen years of this great man were principally employed in the production of his *Cosmos*,—the crowning labor of his long life, the harvest of his mature wisdom,—a work that could not have been produced by any other man, simply because no other man possessed the treasures, or a key to the treasures, of the various knowledge contained in it.

From his return to Europe to his death, he possessed, indisputably, the first place amongst philosophers, for the vast extent of his acquirements. Without doubt, at all times during the present century there have been men much greater than Humboldt in each special department of science, but no one to compare with him in the number of subjects in which he had but few superiors,—no one who could, like him, bring all the sciences into one field of view, and compare them as one whole, through their relations and dependences. It was probably this extent of knowledge that led him to generalization rather than particular discovery; to trace connections and relations, rather than to search for new and minute facts or particular laws; to produce the Cosmos, rather than discover the atomic theory or the cellular formation of organic structures. Many other men have been masters of several specialties. Humboldt alone brought the whole range of the physical and natural sciences into one specialty.

We cannot close this brief notice of the character and career of our illustrious associate without one moment's allusion to his amiable moral nature, his love of justice, and his superiority to all merely personal ends. So strong was his desire to give the influence of his high scientific position to the cause of civilization and the progress of knowledge, by assisting all applicants for his opinion and advice upon scientific subjects, that he permitted a correspondence to be extorted from him which in his last days became a load too great to be borne, and compelled a cry for relief that had hardly subsided when the news of his death reached us.

Such is the faint outline of a man whose name is indelibly written with those who have been most eminent in this wonderful age of scientific activity. The Academy claims the privilege, in common with the learned societies with which he was associated throughout the civilized world, to express its sorrow for his death, and to offer its tribute of honor to his memory.

ART. XVIII.—*On the power possessed by the Larves of various common Flies of consuming, without apparent injury to themselves, the flesh of animals which have died from the effects of Arsenic;* by FRANK H. STORER.

Read before the Boston Society of Natural History, January 5, 1859.

SOME months since my attention was attracted by finding several living maggots upon the liver of a subject in the stomach of which I had previously detected the presence of arsenic. This, eight days after death. As this liver was found, on analysis, to be saturated with arsenic, a number of experiments were made for the purpose of ascertaining whether the larvæ observed had really been nourished by the poisoned flesh on which they were discovered.

Several living rats having been obtained, they were fed with cake which contained arsenious acid in various quantities. After eating this they in every case soon died. Their skins having been removed, the carcasses were exposed in a chamber to which flies had free access. In the course of forty-eight hours the bodies of the rats were thoroughly fly-blown, and were soon covered by a multitude of larvæ. Having completely consumed the flesh of the rats—leaving the bones bare, as in the specimen now exhibited to the Society—the maggots concealed themselves in sheltered corners and were converted into chrysalids in due course. These results were constant, having been exactly similar in every instance. Some two dozen or less of these chrysalids being subjected to analysis, metallic arsenic was readily obtained from them. It might be thought that this proves nothing more than that the flesh of the rats contained arsenic, and that, that obtained from the chrysalids had possibly been mechanically attached to the exterior surfaces of the larvæ and not have been swallowed by them. This view would indeed seem to be supported by the fact that—as may be seen in the specimen presented—the surface of the bones from which the flesh has been thus devoured is covered with a white powder which has the appearance of arsenious acid. However this may be, only two alternatives remain if it is not admitted that the arsenic found in the chrysalids had really been assimilated by the larvæ: either the latter must possess an instinct which leads them to reject altogether the poison, or it is excreted by them after injestion. In the lack of any positive knowledge of the condition in which arsenic or other inorganic poison exists when contained in organic tissues, it seems idle to dwell at greater length on this point.

It would have been interesting to have preserved the chrysalids in order to ascertain whether they were capable of metamorphosis, and if so, whether the perfect insect would have been healthy and vigorous. I therefore kept a number of them during two months, at the end of which time they were accidentally lost. None of these underwent any change, while a number of diminutive flies, apparently not ichneumons, which obtained access to them, died almost immediately, as was supposed from having fed upon them. The chrysalids were however in a perfect state of preservation, being full of pulp, just before they were lost. The empty shells of other chrysalids, which had been formed at the same time as the above, were nevertheless found about the room from time to time within the six weeks following their formation, indicating that some of them had been metamorphosed, as the appearances of these shells were normal and no larvæ other than those which had fed upon the arsenicated specimens had been admitted to the apartment.

Numerous experiments were now made for the purpose of ascertaining how large a quantity of arsenious acid might be contained in flesh without rendering it unfit food for these larvæ; without much success it must be confessed owing to the facility with which animal tissue is hardened by arsenious acid. If bits of flesh are soaked in an aqueous solution of this substance—no matter how dilute the solution may be—the arsenious acid will unite with the exterior portions of the flesh, forming a compound which, when exposed to the air, dries up in a few hours to the hardness of leather and forms an impervious coating. This hardening may indeed be somewhat delayed by wrapping the flesh in moist cloths, in which case the eggs of flies will often be deposited. These eggs produce living worms, unless so much arsenic has been used that the surface of the flesh is covered with a strong solution of it; but these worms never attained maturity in any of my experiments: they perished for the most part on account of the gradual hardening of the flesh which could not be entirely prevented, or from long continued contact with the solution of arsenious acid, a thin film of which was in some instances allowed to cover the surface of the flesh. In this case the grubs, an hour or two after leaving the egg, would commence crawling about very rapidly, evidently much irritated by the solution with which they were surrounded; this motion would be kept up sometimes during six or eight hours before death ensued.

We all know how quickly flies themselves are destroyed by arsenic—it being the active ingredient of nearly all the popular fly-papers, powders and poisons of the shops—it is a matter of no surprise therefore that the parents of the grubs in question

should have perished by scores, as they did while depositing their eggs upon the poisoned flesh. I may here observe that the only reference to this subject which I have been able to find is the remark of Jaeger (quoted by Orfila, *Traitè de Toxicologie*, Paris, 1852, I, 379) that "insects, such as spiders, flies, &c., quickly die when arsenious acid in solution is introduced into their digestive organs or applied to their soft exterior parts. *The larvæ of flies live a little longer than the insects which have undergone metamorphosis.*"

It being impossible to obtain satisfactory results by the method of experimenting which has just been described, I had commenced another series of experiments upon small animals, into the arterial systems of which solutions of arsenic of different degrees of concentration had been injected soon after death. These trials were brought to an abrupt termination by cold weather and the consequent disappearance of all flies. The same difficulties were however experienced here as in the previous cases though in a lesser degree; the flesh having always a tendency to become dry and hard. As this hardening did not take place so rapidly in the injected specimens as where bits of flesh had been soaked in a solution of arsenious acid, so the larvæ were enabled to attain a much larger size, before drying up, than in the previous instances. Indeed in several cases where favorable, moist positions had been secured, they lived for three or four days, becoming quite large and evidently almost ready to pass into the chrysalid state. This, upon the body of a rat weighing seven and a half ounces, into which four and a half grains of arsenious acid in aqueous solution had been injected.

In order to avoid the hardening influence of arsenious acid, solutions of arsenic acid—an eminently hygroscopic substance—were resorted to, but from having been used in too concentrated a state, the larvæ were destroyed, in the course of a few hours after birth, from contact with the solution which had oozed out upon the surface of the flesh; showing clearly, as with arsenious acid, that there is a limit to the amount of arsenic which these larvæ can support.

It is probable indeed that in every case the harmlessness of the poison depends entirely on its being so much diluted that it is no longer present in sufficient dose to destroy the larvæ. I am however inclined to believe that it will be found that they can consume with impunity any flesh into which arsenic has been carried by vital processes. A view which is certainly strongly supported by the fact of finding them upon the arsenicated human liver, an organ which, as is well known, is susceptible of absorbing a particularly large quantity of this poison.

On mentioning these results, some time since, to Prof. Jeffries Wyman, he recalled an instance, similar to those which have been mentioned, that had occurred a short time before in his own dissecting room. The arm of a subject which had been thoroughly injected with a solution of arsenic acid, having been inadvertently thrown aside and left unnoticed for several days was found completely riddled and alive with maggots.

This matter is one of some importance to chemists occupied with judicial investigations, who must not infer that a fly-blown organ can contain no arsenic; and is especially interesting from the fact that several authors have urged that the attention of experts should be particularly directed to the behavior of flies which may alight on any matter suspected of containing poison; if they die almost immediately arsenic is probably present and must be specially sought for. One case at least is on record (vid. Galtier, *Traitè de Toxicologie*, Paris, 1855, I, 406) where the experts having searched in vain for laudanum which was supposed to have produced death, were led to look for arsenic, which they found, from having observed that the flies which fed upon the suspected organs soon perished.

But the subject is also, as it seems to me, worthy the attention of this society, as affording another indication of the great differences which exist between animals in their several conditions of metamorphosis* and of the caution with which all experiments upon the action of remedies or poisons on animals of any one species should be received when brought forward as indications of what that action will be upon other animals.

* I cannot refrain, moreover, from calling attention to its obvious bearing upon the important practical question of the destruction of insects injurious to vegetation, &c.; for it is highly probable that the larvæ of many other insects besides flies are less susceptible to the action of poisons than the perfect insect. Camphor, for example, is esteemed a preventive of the common clothes-moth, and its vapor is doubtless unpleasant to, if not absolutely destructive of, that insect when in its butterfly state; but, as is well known, while it remains a worm it can feed with impunity upon woolen stuffs, no matter how thickly they may be strewn with camphor. In like manner the larvæ of *Dermestes* and *Anthreni*, as proved by the experiments of Dr. Cabot (Proc. Bost. Soc. of Nat. Hist., vii, 5), can consume bird-skins which have been soaked in strong solutions of corrosive sublimate or in a saturated hot solution of arsenious acid, although they will not touch specimens which have been dipped in an alcoholic solution of strychnine.

ART. XIX.—*On some Reactions of the Salts of Lime and Magnesia, and on the Formation of Gypsums and Magnesian Rocks;* by T. STERRY HUNT, F.R.S., of the Geol. Survey of Canada.*

THE importance, in a geological point of view, of gypsum and of the carbonates of lime and magnesia in the forms of limestone, dolomite and magnesite, has led me to make a series of researches, whose results serve to explain many things hitherto obscure in the history of these substances. I propose in the present paper to describe, in the first place, certain chemical reactions of the salts of lime and magnesia; and, secondly, to consider the principal facts in the history of gypsums, and magnesian rocks, and the theory of their formation.

I.

On the action of solutions of bicarbonate of soda on salts of lime and magnesia.

1. In studying some years since the geological relations of alkaline mineral waters I found that by the action of a solution of carbonate of soda, a partial separation of the salts of lime from magnesia could be effected. Subsequent experiments, made with dilute solutions of bicarbonate of soda, have led me to the following results.

If to a solution containing besides common salt the chlorids of calcium and magnesium in the proportion of one equivalent of each, we add a solution of bicarbonate of soda in water saturated with carbonic acid, there separates a gelatinous precipitate, which very soon becomes crystalline. Collected and washed after a few hours, it is found to consist of carbonate of lime with but a small proportion of carbonate of magnesia, which in three successive precipitations from the same saline liquid, was found to equal 2·20, 2·00, and 1·23 per cent. The proportion of separated carbonate of magnesia diminished as the magnesian salts predominated in the solution, which now gave no further precipitate with bicarbonate of soda, but yielded by evaporation to dryness, a granular residue of hydrated carbonate of magnesia, with very little lime. In this way, a litre of the solution gave 4·19 grams of carbonate of magnesia, (MgO, CO_2) and only 0·14 grm. of carbonate of lime, while the soluble portion still retained in the form of chlorid, 1·176 grms. of magnesia, but no lime.

* The experiments detailed in the first section of this paper, as well as some in the second, have appeared in the Report of the Geol. Survey of Canada for 1857; the others of this section, together with those of the third, are from the forthcoming Report for 1858. See also this Journal, [2] xxvi, 110, and the Canadian Journal for May, 1859, p. 184. Many of the original observations in the fourth section already been published in the Reports of the Survey, but are now for the first time brought together.

2. A portion of the saline solution from which about one-third of the lime had been separated as above by bicarbonate of soda, gave by thirty minutes ebullition, a precipitate which for a litre equalled 0·666 grm. of carbonate of lime and 0·173 of carbonate of magnesia. Another portion of the same solution when evaporated to dryness at 120° F., gave 0·805 of carbonate of lime, but no magnesia.

3. If in the preceding experiments we employ a somewhat dilute solution of bicarbonate of soda there is no immediate precipitation of carbonate of lime. A solution was prepared with one litre of water, 29·2 grms. of sea-salt, 13·8 of chlorid of calcium, 50·7 of hydrated chlorid of magnesium, and 10·0 grms. of hydrated sulphate of soda, the three chlorids being in the proportion of two equivalents of the first and third to one of chlorid of calcium. In another litre of water were dissolved 42·0 grms. (equal to two equivalents) of bicarbonate of soda, and the liquid was then saturated with carbonic acid gas. Of this solution, 500 cubic centimeters would have been required to decompose the whole of the chlorid of calcium in the first, and 200 c. c. of it were gradually added to this with stirring, but without producing any visible effect. A further portion of 100 c. c. caused a slight turbidness, which was soon replaced by a crystalline precipitate, adhering to the sides of the vessel, and gradually increasing in amount. After a repose of forty hours at 68° F., the precipitate was collected and analyzed. It weighed 4·3 grms., and was carbonate of lime, with 3·3 p. c. of carbonate of magnesia.

4. The saline liquid, augmented by the washings of the precipitate, now measured 1·400 c. c.; of this one-half was mingled with 100 c. c. of the alkaline solution, being the quantity required for the decomposition of the remaining lime salt. No immediate change was apparent, but at the end of twenty-four hours there had separated a crystalline precipitate, weighing 2·288 grms., and consisting of carbonate of lime with only 2·6 p. c. of carbonate of magnesia.

5. The reason of this separation of lime from magnesia in the above experiments is evident, when we consider that carbonate of magnesia at ordinary temperatures decomposes the soluble salts of lime. Thus, according to Mitscherlich, magnesite or dolomite slowly transforms a solution of gypsum into one of sulphate of magnesia, carbonate of lime being formed at the same time. I have observed a similar reaction between dolomite and a solution of chlorid of calcium, especially at about 125° F. De Senarmont, and after him Bineau, found that solutions of bicarbonate of magnesia decompose chlorid of calcium in the cold, or at temperatures below 212° F. with precipitation of nearly pure carbonate of line, although the assertion of the latter, that sulphate of lime is decomposed by the same agent, is, as I shall

presently show, not quite correct. The power of decomposing gypsum appears to belong only to solutions containing monocarbonate of magnesia.

6. When a portion of moist recently precipitated hydrocarbonate of magnesia is added to a solution of bicarbonate of lime, it is immediately dissolved, but the transparent solution soon becomes turbid from separation of carbonate of lime. A similar reaction is produced by carbonate of soda, which precipitates carbonate of lime from a solution of the bicarbonate.

7. The preceding experiments show a remarkable degree of solubility in recently formed bicarbonate of lime; the liquid in § 4 deposited spontaneously an amount of carbonate of lime equal to 2·6 grms. per litre; and if we add, as in § 2, 0·8 grms. for the amount of carbonate remaining in solution, we shall have 3·4 grms. of carbonate of lime held for a time dissolved as bicarbonate in a litre of saline water, at the ordinary pressure of the atmosphere; the experiment detailed in § 3, indicates a solubility at least as great.

Boutron and Boudet, by treating lime-water with carbonic acid, obtained supersaturated solutions holding 2·3 grms. of carbonate in a litre, but the half of this was soon deposited, and they found that a litre of water charged with carbonic acid, under a pressure of several atmospheres, cannot retain more than 1·16 grms. of carbonate of lime in permanent solution. We have seen in § 2, that a saline solution retains after some hours exposure, 0·805 grms. of carbonate. In other trials I have found 0·838 and 0·915 grms. of carbonate of lime in pure water saturated with carbonic acid at the atmospheric pressure. A solution prepared under a pressure of several atmospheres with excess of carbonic acid, and then exposed for twelve hours in a loosely covered vessel, still retained 0·730 grms. of carbonate of lime in a litre. Bischof estimates the solubility of bicarbonate of lime at one part in 1000, which may be regarded as correct.

Lassaigne found a saturated solution of bicarbonate of lime to contain six equivalents of carbonic acid for one of lime; but from an experiment of Bischof it would appear, that an amount of lime equal to 0·59 grms. of carbonate to a litre may exist in solution as sesqui-carbonate.—(*Lehrbuch der Geologie*, ii, 1126.)

8. According to the same author, when a current of carbonic acid is passed for a long time through water containing pure magnesia in suspensson, there is dissolved a quantity equal to 1·35 grms. of carbonate of magnesia to a litre.—(*Ibid.*, i, 387.) Under certain conditions, however, water is capable of dissolving an amount of carbonate of magnesia many times greater than that stated by Bischof. In § 1 we have seen that a litre of water, containing at the same time chlorids of sodium and magnesium, may hold dissolved as bicarbonate 4·19 grms. of carbonate of mag-

nesia; and by adding known quantities of carbonate of soda to a solution of chlorid of magnesium and passing a current of carbonic acid through the mixture, I have found it easy to obtain permanent solutions, containing not less than 21·0 grms. of monocarbonate of magnesia in a litre. Bineau, by prolonging for several days the action of carbonic acid, obtained a solution which contained in a litre 11·2 grms. of magnesia (equal to 23·5 grs. of magnesian carbonate), combined with very nearly two equivalents of carbonic acid.

The observations of H. Rose, and of Longchamp, show that the presence of alkaline chlorids, sulphates or carbonates, as well as of magnesian salts, increases the solubility of carbonate of magnesia in water. This may explain the great difference between the determination of Bischof, in which all foreign salts were excluded from the solution, and the experiments of Bineau and myself, with solutions which always contained salts of soda or magnesia. That the presence of such salts does not, on the contrary, augment the solubility of bicarbonate of lime, is apparent from § 2.

9. Bineau found that during the spontaneous evaporation of a solution of bicarbonate of magnesia carbonic acid escaped, and carbonate of magnesia separated, until at length the liquid retained in a litre only from 0·10 to 0·17 grms. of carbonate of magnesia, with sufficient carbonic acid to form a sesquicarbonate. Such solutions, when transferred to closed vessels, were spontaneously decomposed, hydrated carbonate of magnesia separating while a bicarbonate remained in solution.—(*Ann. de Chim. et de Phys.*, [3], li, 302.)

This spontaneous decomposition of the sesquicarbonate of magnesia into monocarbonate and bicarbonate is somewhat analogous to that exhibited by a recent supersaturated solution of bicarbonate of lime, which as we have seen, breaks up into an insoluble monocarbonate and free carbonic acid or a very acid salt. The reaction is observed in a remarkable manner during the evaporation of certain saline mineral waters, which contain abundance of bicarbonate of magnesia. A portion of water from the Plantagenet spring was left to evaporate in an open basin in summer, until its volume was reduced to one-fifth. The clear solution was then decanted from a crystalline crust of carbonates of lime and magnesia, and transferred to a carefully closed flask, where after two or three days, it deposited a strongly adherent crust of hydrated carbonate of magnesia, chiefly on the lower parts of the vessel. The amount of this deposit was equal to 0·772 grms. of carbonate of magnesia to a litre of the concentrated liquid, which contained no lime, but abundance of bicarbonate and chlorid of magnesium, after the separation of the precipitate.

II.

On the reaction between solutions of bicarbonate of lime and the sulphates of soda and magnesia.

10. If to a solution of bicarbonate of lime we add a portion of sulphate of soda or sulphate of magnesia, there are formed by double decomposition, bicarbonate of soda or bicarbonate of magnesia and sulphate of lime, which latter salt may be precipitated by the addition of alcohol.

To 400 cubic centimeters of a recently prepared transparent solution of bicarbonate of lime there were added two grams of hydrated sulphate of soda, and the solution was then mingled with an equal volume of alcohol of 90 p. c. A white flocculent precipitate immediately appeared, which was collected after a few hours, and washed with dilute alcohol. It was completely soluble in water, but was again thrown down by alcohol, with the addition of a few drops of hydrochloric acid, and was pure sulphate of lime, weighing, when ignited, 0·428 grms., which corresponds to 0·915 grms. of carbonate of lime to the litre.

11. 400 c. c. of the same solution of bicarbonate of lime were treated with 2·0 grms. of crystallized sulphate of magnesia and alcohol, as above; the precipitated sulphate of lime equalled 0·467 grm. The filtrate from which the alcohol had been expelled gave by boiling, a copious precipitate containing a little lime and 0·276 grms. of carbonate of magnesia; theory requires 0·288.

12. 500 c. c. of a recent solution of bicarbonate of lime with 2·0 grms. of hydrated sulphate of soda and an equal volume of alcohol, gave a precipitate of gypsum, which when dissolved in water and reprecipitated as in § 10, gave 0·570 of sulphate of lime, equal to ·838 grm. of carbonate of lime to a litre. The alkaline filtrate was evaporated to dryness, the residue redissolved, and precipitated at a boiling heat by a dilute solution of chlorid of calcium. The carbonate of lime thus obtained was free from sulphate, and corresponded to ·445 grm. of carbonate of soda; theory demands ·442.

13. In consequence of this formation of gypsum, the solubility of carbonate of lime in carbonic acid water is, as I have found, very much increased by the presence of sulphate of soda, or sulphate of magnesia. To a little more than 200 c. c. of lime-water were added 4·0 grms. of sulphate of soda, and a stream of carefully washed carbonic acid gas was then passed through the liquid for four hours, at the end of which time the solution of the carbonate of lime was nearly complete. On the addition of an equal volume of absolute alcohol, there fell a precipitate of gypsum, which, when washed, effervesced slightly with hydrochloric acid from a trace of carbonate of lime; but being again thrown down from its aqueous solution by alcohol, gave 0·555 grms. of ignited

sulphate of lime, equal to about 2·0 grms. of carbonate of lime to a litre. The carbonate of soda in the alkaline filtrate was found, by the indirect method of § 12, equal to ·434 grm.; theory requires ·432.

14. In another experiment, a dilute solution of sulphate of soda was treated with an excess of bicarbonate of lime, in order to determine whether it were possible to decompose completely the soda-salt by this means. After throwing down the gypsum by alcohol, the residue contained for a litre 1·080 of carbonate and 0·520 of sulphate of soda.

15. 250 c. c. of water, containing ten grams of hydrated sulphate of soda, and two grams of pure carbonate of lime, were exposed for an hour and a half to a current of carbonic acid gas, and the solution was then left for four hours in a covered flask, after which 150 c. c. of the clear liquid were mixed with an equal volume of absolute alcohol. A copious precipitate was formed, which, after twelve hours, was collected; it was completely soluble in 200 c. c. of water, from which alcohol threw down ·343 grms. of sulphate of lime, besides a farther portion of ·020 grs. from the evaporated filtrate, making a total of 363 grs., equal to 2·420 grs. of sulphate of lime to the litre.

16. 200 c. c. of a similar solution to the last, gave with alcohol, a precipitate of gypsum, which was readily soluble in water, and being thrown down as oxalate, gave an amount of carbonate of lime equal to 1·820 grms. to the litre, or 2·475 of sulphate of lime.

17. A current of carbonic acid gas was passed for an hour and a quarter through a solution containing sulphate of magnesia and carbonate of lime. The filtered liquid remained transparent after many hours exposure to the air; but 200 c. c. of it gave with alcohol a precipitate of gypsum, which was collected after twelve hours and was completely soluble in water, from which solution the lime was thrown down as oxalate, giving an amount of carbonate equal to 1·565 grms. or to 2·128 grms. of sulphate of lime to the litre. The alcoholic filtrate by evaporation to dryness over a water-bath, gave a little carbonate of lime, and an amount of carbonate of magnesia equal to 1·100 grms. to the litre; theory requires 1·312, but it is difficult to separate in this way the whole of the carbonate of magnesia from an excess of sulphate.

18. It thus appears that in the presence of sulphate of soda or magnesia, water saturated with carbonic acid is capable of dissolving nearly twice the ordinary proportion of carbonate of lime, or from 1·565 to 1·820 grms. to the litre. The lime in these liquids is doubtless to be regarded as existing chiefly as sulphate, of which salt they are nearly saturated solutions. The determinations, in § 15, § 16 and § 17, give respectively one

part of sulphate of lime for 413, 404 and 459 parts of water. The solubility of this salt in pure water has been variously stated. According to Bucholz, one part of sulphate of lime requires 460 parts of hot or cold water for its solution; but Giese gives 380 parts of cold, and 388 of boiling water, its solubility being increased, according to O. Henry, by the presence of sulphate of soda.—(Gmelin, *Handbook*, (Cavendish ed.,) iii, 202.)

I determined the amount of sulphate of lime in a solution prepared by agitating frequently for several days, pure artificially prepared gypsum, with distilled water, at 60° F. The lime was thrown down as oxalate, and indicated one part of sulphate of lime to 483 parts of water. Another portion of the same solution was evaporated at a gentle heat until crystals of gypsum separated, and the clear saturated solution decanted from these crystals after twelve hours of repose at 60° F., contained one part of sulphate of lime for 372 parts of water, which approaches closely to the determination of Giese.

19. In a late paper, by Bineau, on the earthy carbonates already cited (*Ann. de Chim. et de Phys.*, [3] li., 297), the author refers to a memoir of Mr. E. Marchand, who asserts that a litre of water may hold dissolved as bicarbonate, about 2·5 grms. of carbonate of lime, and that sulphate of lime and alkaline bicarbonates may co-exist in natural waters. These statements are controverted by Bineau, but the latter of them is fully sustained by the experiments which we have described, while the augmented solubility of the carbonate of lime is to a great extent explained if the solutions of Marchand contained soluble sulphates. I have not however been able to verify the assertion of Marchand, that sulphate of lime separates from mixed solutions of bicarbonate of lime and sulphate of soda, unless indeed by the intervention of alcohol; although as will now be shown gypsum may be crystallized from mingled aqueous solutions of bicarbonate of lime and sulphate of magnesia.

20. When a solution like that of § 17 is evaporated at a gentle heat, it might be expected that carbonate of lime, being a less soluble salt than gypsum, or the carbonate of magnesia, would be deposited. I have found, however, that from such a solution under these conditions, gypsum separates, while bicarbonate of magnesia remains in solution. The sulphate of magnesia employed in the following experiments was carefully recrystallized and contained no traces of lime or free acid; its solution did not alter the color of curcuma, but slowly restored that of reddened litmus. The carbonic acid employed was evolved from limestone hydrochloric acid, and carefully washed, so that its solution was not troubled by nitrate of silver.

To 500 c. c. of water were added twelve grams of sulphate of magnesia and half a gram of precipitated carbonate of lime, and

a current of carbonic acid gas passed for two hours through the liquid, when the carbonate of lime was nearly all dissolved. The solution was now evaporated in a porcelain basin at a temperature varying from 90° to 110° F., until crystals of sulphate of magnesia separated; a little water was then added and the solution, being immediately filtered, contained no lime-salt, but was strongly alkaline to curcuma paper. When heated it became turbid before boiling, and after fifteen minutes ebullition deposited a flocculent precipitate containing ·208 grm. of carbonate of magnesia. The basin in which the evaporation had been conducted was covered with a crystalline crust which effervesced but slightly with hydrochloric acid; it was soluble in a large volume of water, and was principally gypsum.

21. To 800 c. c. of water were added twenty grams of sulphate of magnesia and one gram of pure carbonate of lime; a current of gas was now passed through the liquid for an hour and a half, when the lime was nearly all dissolved; the solution was saturated with the gas, but contained no trace of chlorine. It was neutral to curcuma, and gave with alcohol a precipitate of gypsum. A portion of it heated to boiling remained clear for five minutes, but then grew turbid and deposited an abundant precipitate of carbonate of lime.

200 c. c. of this solution were evaporated at a temperature of 180°–190° F., until crystals of sulphate of magnesia separated; after twelve hours repose in the cold a little water was added and the solution decanted from a precipitate, of which ·272 grm. were collected; when this was treated with hydrochloric acid and dilute alcohol a portion of carbonate of lime was removed and there remained ·236 grm. of crystalline gypsum, weighing when ignited, ·185, equal to ·925 grm. of sulphate of lime to the litre. The filtered solution of sulphate of magnesia was strongly alkaline to curcuma, and gave by boiling, a precipitate which contained no lime but a portion of carbonate of magnesia equal to ·490 grm. to the litre; theory demands ·570.

22. A solution of twelve grams of sulphate of magnesia in 300 c. c. of water was mingled with carbonate of lime and saturated with carbonic acid. It was then filtered and evaporated at about 160° F., until sulphate of magnesia separated. By this means a sparingly soluble crystalline precipitate was formed, which contained gypsum equal to ·235 grm. of sulphate of lime, with a little carbonate. The filtrate gave by boiling a precipitate of carbonate of magnesia which equalled ·098, while theory demands ·145.

To 600 c. c. of a solution of bicarbonate of lime were added twenty grams of sulphate of magnesia, when the liquid which was before turbid from a portion of suspended carbonate, became clear, and gave by evaporation at 90° F. a precipitate contain-

ing ·154 of sulphate of lime, with some carbonate of lime and a trace only of magnesia.

A solution of five grams of sulphate of magnesia was mingled with a portion of solution of bicarbonate of lime, and evaporated at 160°–180° F., further portions of the latter, amounting in all to 300 c. c. being added as the evaporation went on. There was deposited a mixture of carbonate of lime, with crystalline gypsum equal to ·373 grm. of sulphate of lime to the litre.

23. It will be remarked, that while the recent solution containing gypsum and carbonate of magnesia with excess of carbonic acid is neutral to curcuma and may be boiled for some minutes before a precipitate of carbonate appears, the liquid from which gypsum has been deposited by evaporation is strongly alkaline to curcuma paper, and lets fall a precipitate of carbonate of magnesia, even before attaining the boiling point; this precipitate is in part redissolved as the liquid cools. When this alkaline liquid is mixed with a solution of gypsum, it deposits in a few hours, especially if gently warmed, a crystalline precipitate of carbonate of lime, resulting from the decomposition of the sulphate of lime by the carbonate of magnesia.

The sulphate of magnesia retains the carbonate of magnesia in solution in such a manner that the latter is not rendered completely insoluble, even when the liquid is evaporated to dryness over a water-bath. Hence the deficiency observed in the determinations of carbonate of magnesia in § 17, § 21 and § 22, where a large proportion of sulphate was present. The filtrate from the carbonate in these cases is still alkaline, and gives with nitrates of silver and copper, precipitates of carbonates.

24. In the preceding experiments all salts, other than those concerned in the reaction, were excluded, but similar results are obtained in the presence of sea-salt and chlorid of magnesium. Twenty grams of pure chlorid of sodium, and ten grams of sulphate of magnesia, with a portion of carbonate of lime, were added to 800 c. c. of water, and the solution saturated with carbonic acid gas. Of this liquid 400 c. c. were evaporated at 160°–180° F., until sea-salt separated, and gave ·045 grm. of sulphate of lime, mixed with ·291 of carbonate.

Ten grams of chlorid of sodium, and twenty grams of crystallized chlorid of magnesium were added to 600 c. c. of solution of bicarbonate of lime, containing two grams of sulphate of magnesia; 300 c. c. of this solution were now evaporated at 160°–180° F., until crystals of sea-salt appeared; there were obtained ·057 grm. of sulphate of lime.

25. A saturated solution of one part of sea-salt and two parts of sulphate of magnesia was exposed to a cold of 32° F., when a large amount of sulphate of soda separated. The mother liquor, containing besides some sea-salt and sulphate of magnesia, a

large amount of chlorid of magnesium, was diluted with four parts of water. 500 c. c. of this solution were mingled with carbonate of lime, saturated with carbonic acid, and then evaporated at a temperature of 85°–90° F., to one-twelfth, when crystals of sea-salt separated, and a crystalline residue of gypsum was obtained. It did not effervesce with hydrochloric acid, and was soluble in a large volume of water. The saline liquid by evaporation to dryness, gave ·331 of carbonate of magnesia.

To another portion of 100 c. c. of the saline solution employed in the last experiment, 500 c. c. of a solution of bicarbonate of lime were gradually added, the mixture being meanwhile evaporated at a temperature below 100° F., and at length carried to dryness. On treating the mass with water, the strongly saline filtrate was found to contain no lime-salt, but sulphate of lime was abundant in the washings, and the residue on the filter, when treated with hydrochloric acid, left crystalline grains of gypsum.

26. In the foregoing experiments it is not easy to separate the more soluble salts from the gypsum, which, although insoluble in saturated saline liquids, is readily dissolved by washing with water, in place of which a solution of gypsum may be used. In either case, as a solution of sulphate of lime is decomposed by the dissolved carbonate of magnesia, the washings should not be mingled with the alkaline filtrate in which we wish to determine this salt. As a solution of magnesian carbonate which has lost its excess of carbonic acid by evaporation is incompatible with dissolved gypsum, it is evident that the presence of an excess of this acid must be one of the conditions required for the crystallization of gypsum from such a solution. It often happens that some slight variations in the conditions of the experiment with two portions of the same solution, will give in one case abundance of gypsum and in the other chiefly carbonate of lime.

27. The power of bicarbonate of baryta to decompose sulphate of magnesia and even sulphate of soda with precipitation of sulphate of baryta is well known; and I have found that the insolubility of the sulphate of strontia determines a similar result. A solution of bicarbonate of strontia, prepared by passing carbonic acid gas through water holding the carbonate in suspension, was divided into two portions, one of which was mingled with a portion of sulphate of soda and the other with sulphate of magnesia. The mixtures, at first clear, soon became troubled from the separation of a precipitate, which adhered to the sides of the vessels, and like ammonio-magnesian phosphate, along the lines marked by the rod in stirring. After twelve hours the liquids decanted from the precipitate, which was in each case, sulphate of strontia, were evaporated at a gentle heat to a small volume, during which process they deposited a portion of car-

bonate of strontia. The first contained some sulphate, with a large proportion of carbonate of soda, and the second, which gave no trace of dissolved strontia, let fall by boiling a copious precipitate of magnesian carbonate.

An analogous reaction between the sulphates of iron and zinc and bicarbonate of lime, resulting in the production of gypsum and carbonates of zinc and iron, has already been suggested by Monheim to explain the association of these minerals in a modern deposit from the waters of a mine. The experiments of Bischof have established the fact of such a decomposition for the sulphate of copper, as well as for the sulphates of zinc, and protoxyd of iron.—(*Lehrbuch*, ii, 1198–1202.)

III.

On the formation of the double carbonate of lime and magnesia.

28. The carbonates of lime and magnesia, although so frequently combined in nature in the form of dolomite, exhibit, under ordinary circumstances, little disposition to unite with each other. The carbonate of lime, as we have seen, separates nearly pure, from solutions of bicarbonate of magnesia, at ordinary temperatures; and if by the aid of heat a portion of magnesian carbonate is at the same time precipitated, the two appear to be only in a state of admixture.

Karsten long since observed that dilute acetic acid, at temperatures below 32° F., readily dissolves carbonate of lime, but is without action on the double carbonate of lime and magnesia, which constitutes dolomite. By this means he was enabled to make a proximate analysis of many magnesian limestones, which he found to be mixtures of dolomite with carbonate of lime. Before undertaking a series of experiments on the production of this double carbonate, I endeavored to fix by experiment the limits of error in Karsten's process.

29. For this purpose I took a pure acetic acid, containing 29·4 p. c. of glacial acid; this was mixed with an equal volume of water, so that the dilute acid used in the following experiments contained about 15 p. c. of glacial acetic acid. Unless otherwise specified, it was employed at 32° F. (lower temperatures being difficult to regulate), and this temperature was maintained by a bath of ice and water. In these conditions the acid dissolved precipitated carbonate of lime and pulverized limestone with lively effervescence, even when farther diluted. A pure crystalline dolomite in fine powder was however slowly attacked, subsiding to the bottom of the liquid, and disengaging small bubbles of gas from time to time. After six hours digestion, with a large excess of the acid at 32° F., 1·68 grs. of this dolomite had lost ·082 of carbonate of lime, and ·063 of carbonate

of magnesia, equal to 8·63 p. c. of dolomite, (containing 43·5 p. c. of magnesian carbonate). At a temperature of 60° F., the same acid caused a slow but continued disengagement of gas bubbles from the powdered dolomite, which after 30 hours lost 28·0 p. c. of its weight, the dissolved portion containing 45·0 p. c. of carbonate of magnesia. At 125° F. the action of the acid upon the powdered dolomite was accompanied with gentle effervescence, and the amount dissolved after two hours digestion, was 13·6 per cent.

A white crystalline magnesite from Styria, whose only impurity was a portion of carbonate of iron equal to 0·9 p. c. of peroxyd, and which was slowly but completely soluble in hot hydrochloric acid, was also slightly attacked by dilute acetic acid at 60° F.; after twelve hours digestion there were dissolved 0·63 p. c. of the carbonate. At 125° F. however a distinct effervescence was produced with the acid, and at the end of three hours 11·0 p. c. of the magnesite were dissolved.

From these experiments it was evident that although not insoluble in acetic acid of 15·0 p. c. at 32° F., this liquid might serve to separate dolomite from carbonate of lime, and also at a higher temperature to effect a partial separation of dolomite from magnesite.

30. The insolubility of the double carbonate of lime and magnesia in carbonic acid water is also an important fact in the history of dolomite. Bischof found that by the prolonged action of a solution of carbonic acid upon a limestone containing 11·54 p. c. of magnesian carbonate, there were dissolved 4·29 p. c. of carbonate of lime and not a trace of magnesia. In like manner a manganesian iron-spar, which contained 14·0 p. c. of carbonate of lime and 15·0 p. c. of carbonate of magnesia, gave to carbonic acid water four parts of carbonate of lime for one part of magnesian carbonate.—(*Lehrbuch*, ii, 1176.)

31. Accepting the idea that dolomites have been formed by the alteration of beds of carbonate of lime, Haidinger long since suggested that a solution of sulphate of magnesia at a high temperature might produce this change, giving rise by double decomposition to carbonate of magnesia and sulphate of lime, although Mitscherlich had shown that at ordinary temperatures sulphate of lime and carbonate of magnesia are mutually decomposed (§ 5). Von Morlot subsequently verified this conjecture of Haidinger; he found that by heating together to 200° centigrade, for six hours in a sealed tube a mixture of two equivalents of carbonate of lime and one equivalent of crystallized sulphate of magnesia, the latter was completely decomposed, with the production of sulphate of lime and carbonate of magnesia, which he seems to have regarded as forming with the excess of carbonate of lime a double carbonate.—(Liebig and Kopp,

Jahresbericht, 1848, ii, 500). Desirous of verifying this observation I have repeated the experiment of von Morlot, but have found that although the sulphate of magnesia is indeed completely converted into carbonate, this remains for the most part in the form of magnesite mechanically intermixed with the excess of carbonate of lime, which may be separated by the aid of dilute acetic acid.

32. 100 parts of pure precipitated carbonate of lime (two equivalents) and 123 parts of crystalized sulphate of magnesia (one equivalent) were intimately mingled and exposed in sealed glass tubes for six hours to a temperature of 392° F. (200° C.) The resulting white tasteless mass was treated with cold dilute acetic acid which immediately caused a strong effervescence. When this action had subsided the residue was washed with cold water and then treated with dilute hydrochloric acid which produced no effect in the cold, but by the aid of a gentle heat dissolved a large portion with effervescence. The addition of alcohol threw down abundance of gypsum from the solution, and the filtrate from this being evaporated to dryness and then moistened with hydrochloric acid, was digested with absolute alcohol, by which the chlorids alone were dissolved, leaving a small residue of gypsum, and were found to consist of chlorid of magnesium with but very little chlorid of calcium. The acetic acid on the contrary had dissolved a large portion of carbonate of lime with but little carbonate of magnesia and a little gypsum. Thus in one experiment the acetic solution gave besides ·079 of sulphate, ·523 of carbonate of lime and ·016 of carbonate of magnesia, equal to 3·0 p. c. of the dissolved carbonates, while the portion insoluble in acetic acid, separated from gypsum by the process just described, gave ·459 of carbonate of magnesia and ·017 of carbonate of lime, or 96·3 p. c. of magnesian carbonate. In another experiment there was obtained from the residue insoluble in acetic acid, carbonate of magnesia ·437, carbonate of lime ·020.

The crystallized sulphate of magnesia undergoes the aqueous fusion at about 230° F., and contains sufficient water to render the mixture with carbonate of lime somewhat moist after heating. The above experiment was however repeated with the addition of a portion of water, but with the same result as before; the carbonates not dissolved by acetic acid consisted of ·242 of carbonate of magnesia and ·008 of carbonate of lime.

33. The experiments of de Senarmont have shown that when carbonate of magnesia is formed at a temperature of 150°–175° C. by the reaction between solutions of sulphate of magnesia and carbonate of soda, or by the decomposition of a solution of bicarbonate of magnesia, it separates as a crystalline powder sparingly soluble in acids and apparently identical with magnesite. —*Ann. de Chim. et de Phys.* [3], xxxii, 148. It is evident from

the results just detailed that a similar result takes place when carbonate of lime is substituted for the carbonate of soda, the carbonate of magnesia formed in the presence of an excess of carbonate of lime retaining only three or four per cent of this carbonate.

34. According to Marignac, when carbonate of lime is heated in sealed tubes with a solution of chlorid of magnesium to 200° C. for six hours, there is obtained, besides a portion of chlorid of calcium, a product consisting of 48·0 parts of carbonate of lime and 52·0 of carbonate of magnesia; at the end of two hours' heating, the proportion of magnesian carbonate was less. (*Bul. Soc. Geol. de France* [2] vi, 318.) It does not appear whether Marignac examined the product by the aid of acetic acid, but I find that in this process a double carbonate of lime and magnesia is really formed.

A mixture of six parts of pure precipitated carbonate of lime with five parts of pure crystallized hydrated chlorid of magnesium, dissolved in a little water, was placed in sealed tubes and heated for eight hours to a temperature of 150° C. which was gradually raised to 220° C. Two hours after cooling, the matter was removed from the tubes, washed, dried, and treated with dilute acetic acid, which caused a violent effervescence; as soon as this had subsided, the filtrate, which contained a large excess of acid and still attacked carbonate of lime with energy, was separated by filtration from the undissolved residue which was but little more than one-fifth of the whole. The dissolved portion consisted in 100 parts of carbonate of lime 96·86, carbonate of magnesia 3·14.

35. Previous experiments had shown me that in operating with glass tubes, a portion of silicate of magnesia is always formed,* and as this is decomposed by mineral acids, acetic acid was employed in the analysis of the undissolved carbonates, of which ·800 grm. from the last experiment were treated with acetic

* The glass of the tubes is always more or less attacked in these experiments, water alone at the temperature employed dissolving from it a portion of alkaline silicate, which by double decomposition with carbonate or chlorid gives rise to a silicate of magnesia. A mixture of carbonates of lime and magnesia with water and carbonate of soda having been heated for several hours in glass tubes to 150°–170° C. the greater part of the magnesia was found to be changed into a light flocculent hydrated silicate insoluble in acetic acid, but decomposed without effervescence by digestion with hydrochloric acid, which took up a large portion of magnesia with only a trace of lime, and left granular silica. I have not yet obtained this silicate in sufficient purity to determine its precise constitution.

When a mixture of magnesite and crystalline quartz was heated for several weeks in a copper vessel with a solution of carbonate of soda to 130° C. it was found that nearly the whole of the quartz had been converted into a hydrous silicate of magnesia, after decomposing which by sulphuric acid the now soluble silica could be taken up by a boiling solution of carbonate of soda. I reserve for another place the results of a series of researches upon the artificial formation of silicates by the reaction of silica upon carbonates, which as I have elsewhere shown plays a most important part in the chemical alteration of sedimentary rocks.—*Proc. Royal Society*, and this Journal, [2], xxiii, 437.

acid of 15 p. c. at 60° F. No action was apparent even after some minutes, but with a heat of 120° F. a gentle effervescence ensued. When this ceased there remained a flocculent residue equal to 15·7 p. c., and the undissolved portion gave carbonate of lime 37·6, carbonate of magnesia 62·4.

A portion of ·500 grm. of the same carbonates was now digested with dilute acetic acid at 60° F. for several hours. The soluble portion contained carbonate of lime 40·0, and carbonate of magnesia 60·0, while the undissolved residue equalled 22·4 p. c. It effervesced freely with warm somewhat dilute hydrochloric acid and left a silicious residue of ·032 grm., while the dissolved portion gave ·007 of carbonate of lime and ·060 of carbonate of magnesia.

36. In another experiment with carbonate of lime and chlorid of magnesium, the mixture of carbonates as extracted from the tubes contained 24·4 p. c. of magnesian carbonate. This was treated with acetic acid at 60° F., and the digestion continued for some length of time, the result of which was that a large portion of the double carbonate was taken up and the dissolved portion contained 11·4 p. c. of carbonate of magnesia, while the undissolved residue was carbonate of magnesia with but 30·3 p. c. of carbonate of lime, and in a third experiment under similar circumstances contained only 23·6 per cent. These experiments were made before I had determined the solubility of the double carbonate in acetic acid at the ordinary temperature.

It is evident from the above results that these magnesian carbonates, which retain after the action of acetic acid from 23·0 to 37·0 p. c. of carbonate of lime, are mixtures of a double carbonate of lime and magnesia with a less soluble carbonate of magnesian, from which the double salt may be partially separated by the prolonged action of acetic acid at ordinary temperatures, as shown in § 35.

37. In the experiments § 34 and § 36 it appears that the carbonate of magnesia unites, at the moment of its formation, with a portion of carbonate of lime to form the double carbonate. It remained to be seen whether mixtures of the two carbonates would combine directly, and experiments were made with the Styrian magnesite (§ 29) which was mingled in fine powder with carbonate of lime and heated for some hours in sealed tubes to 200° C. with a dilute solution of chlorid of calcium. No combination took place, and the carbonate of lime was afterwards completely removed from the magnesite by cold dilute acetic acid.

The dense insoluble magnesite, as might be conjectured from its occurrence in the products of the previous experiments, exhibits none of that aptitude to combine with carbonate of lime which seems to characterize the newly formed magnesian carbonate before passing into this sparingly soluble condition, a

change as we have seen in the experiments of de Senarmont (§ 33) takes place at from 155° to 175° C. The hydrated carbonates of magnesia formed at low temperatures and readily soluble in dilute acids, are in like manner, when heated under pressure, to prevent the loss of carbonic acid, converted into magnesite; if under these conditions carbonate of lime be present the two combine to form a double salt, possessing the chemical characters of dolomite.*

38. In his researches on the double carbonates, H. Deville has described an anhydrous crystalline salt composed of one equivalent each of the carbonates of magnesia and soda. This double carbonate is insoluble in cold water, but readily dissolves in acetic acid. When it is heated with a solution of chlorid of magnesium in sealed tubes to 200° C. chlorid of sodium and sparingly soluble magnesite are obtained. When warmed with a solution of chlorid of calcium this double carbonate is decomposed and gives rise to a mixture of carbonates of lime and magnesia readily soluble in acetic acid; at a higher temperature under pressure the two carbonates unite to form a double salt.

39. Three parts of the finely pulverized carbonate of magnesia and soda were added to two parts of chlorid of calcium dissolved in a little water and rendered slightly acid by hydrochloric acid. The mixture being placed in hermetically sealed glass tubes, these were heated for some hours in a bath of boiling water with frequent agitation, and then in an oil-bath for eight hours, the temperature being slowly raised from 130° to 220° C. On cooling, the saline liquid in the tubes was found to contain, besides chlorids of sodium and calcium, a considerable amount of chlorid of magnesium. A portion of the double salt became coated over by the precipitated carbonate of lime and thus protected from the further action of the chlorid of calcium.

The carbonates from the above experiment were treated with a large excess of dilute acetic acid at 60° F. till effervescence ceased. ·600 grm. of the residue were now digested for two hours with dilute acid at 60° F.; the action was accompanied with a slow and constant disengagement of carbonic acid gas, and the solution gave ·302 grm. of carbonates, of which the carbonate of lime constituted 41·3 p. c. The undissolved portion effervesced with

* I have shown, from a consideration of the densities of the rhombohedral carbon spars, that supposing them to possess a common atomic volume, we may represent calcite by $15(C_2M_2O_6)$ while dolomite and chalybite are $18(C_2M_2O_6)$ and magnesite and carbonate of zinc (smithsonite) $20(C_2M_2O_6)$. Farther examples of polymerism in mineral compounds are seen in sillimanite and cyanite, in meionite and zoisite (saussurite), and in hornblende and pyroxene. These latter, accepting the late analyses of Rammelsberg, may be represented respectively by $25(SiMO_3)$ and $28(SiMO_3)$, wollastonite being $22(SiMO_3)$; these formulas correspond to three types of homœomorphous isomeric silicates. (See this Journal, [2], xvi, 203, and *Comptes Rendus de l'Acad.* 1855, xli, 79.)

warm hydrochloric acid, which dissolved ·178 of carbonates containing only 12·3 p. c. of carbonate of lime, leaving ·116 grm. of insoluble silicious residue.

40. In a repetition of the above experiments the carbonates were treated with acetic acid at 32° F. till effervescence ceased, and a portion of the remaining double carbonate was digested for some time with acetic acid at 125° F. which took up 80·0 p. c. of carbonates containing 38·4 p. c. of carbonate of lime. The insoluble portion did not effervesce with hydrochloric acid, which however removed from it a portion of magnesia but no lime, and left a silicious residue. Another portion was digested for several hours with acetic acid at 60° F. which took up 78·0 p. c. of carbonates containing 40·8 of carbonate of lime. The insoluble residue effervesced freely with warm sulphuric acid, which dissolved a portion of magnesia but no trace of lime.

41. Other experiments were made in which carbonate of lime was mingled with solutions of sulphate of magnesia and carbonate of soda, so that carbonate of magnesia would be formed, the sulphate of magnesia being in slight excess in one case and the alkaline carbonate in another. In another experiment, a mixture of ter-hydrated carbonate of magnesia and carbonate of lime with water and carbonate of soda, was employed. All of these were heated in metallic tubes to from 130° to 200° C. and the products digested for a long time with acetic acid at 60° F. These experiments were made at a time when I had not determined the solubility of the double carbonate under such conditions, and the consequence was that the residues obtained were chiefly carbonate of magnesia, which was scarcely attacked by cold acids, but retained in the form of the double salt from six to eleven per cent of carbonate of lime. In another trial, however, a mixture of hydro-carbonate (*magnesia alba*) and carbonate of lime with water and an excess of bicarbonate of soda was exposed in the boiler of a steam engine to a temperature of from 120° to 130° C. for several hours every day during ten weeks. The washed residue was then digested with acetic acid only until effervescence ceased; after which it was completely soluble in hydrochloric acid, and gave carbonate of lime 46·3, carbonate of magnesia 53·7.

42. The preceding experiments show that carbonate of magnesia, whether (1) as magnesia alba in presence of excess of carbonic acid, from bicarbonate of soda, or (2) a ter-hydrated carbonate, or (3) as precipitated by bicarbonate of soda from sulphate of magnesia, or (4) by carbonate of lime from a solution of chlorid of magnesium at an elevated temperature, or (5) as separated from the double carbonate of magnesia and soda by a solution of chlorid of calcium, will in the presence of water unite directly with carbonate of lime to form a double carbonate of lime and

magnesia, sparingly soluble in cold dilute acetic acid. This combination takes place between 130° and 200° C., at which temperatures the magnesian carbonate tends to pass into the still less soluble state of magnesite, in which, as we have shown, it no longer shows any disposition to unite with carbonate of lime. Hence it happens that in all our experiments a portion of magnesite is mingled with the dolomite, and cannot be completely separated from it. Dilute acids slowly attack both, but unequally, so that we finally obtain a residue which contains carbonate of magnesia free from lime: but the solution having taken up a portion of magnesite, contains more magnesia than is required to form a dolomite with the carbonate of lime; so that we have from 53·0 to 60·0 p. c. of magnesian carbonate instead of 45·0 as in pure dolomite. In nature the combination of the two carbonates has doubtless taken place slowly, and necessarily at the lowest temperature, which is probably much below 130° C., so that we may suppose that it is only in the absence of a sufficient quantity of carbonate of lime that a portion of the magnesian carbonate has been converted into magnesite.

(*To be concluded in the next No.*)

ART. XX.—*Extract from the concluding part of a Memoir on the Botany of Japan, in its Relations to that of North America, and of other parts of the Northern Temperate Zone;* by ASA GRAY.*

IT is interesting to notice that, notwithstanding the comparative proximity of Japan to Western North America, fewer of its species are represented there than in far distant Europe. Also,—showing that this difference is not owing to the separation by an ocean,—that far more Japanese plants are represented in Eastern North America than in either. It is, indeed, possible that my much better knowledge of American botany than of European may have somewhat exaggerated this result in favor of Atlantic North America as against Europe, but it could not as against Western North America.

If we regard the identical species only, in the several floras, the preponderance is equally against Western as compared with Eastern North America, but is more in favor of Europe. For the number of species in the Japanese column which likewise occur in Western North America, is about 120: in Eastern North America, 134; in Europe, 157.

Of the 580 Japanese entries, there are which have corresponding

European representatives, a little above				8.48	per cent	of identical species,	0.27
Western N. American representatives, about				0.37	"	" " "	0.20
Eastern	"	"	"	0.61	"	" " "	0.23

* Extracted from the Memoirs of the American Academy of Arts and Sciences, new series, vol. vi.

So geographical continuity favors the extension of identical species; but still Eastern North America has more in common with Japan than Western North America has.

The relations of this kind between the floras of Japan and of Europe are obvious enough; and the identical species are mostly such as extend continuously—as they readily may—throughout Russian Asia, some few only to the eastern confines of Europe, but most of them to its western borders. To exhibit more distinctly the features of identity between the floras of Japan and of North America, and also the manner in which these are distributed between the eastern and the western portions of our continent,—after excluding those species which range around the world in the northern hemisphere, or the greater part of it, or (which is nearly the same thing in the present view), which are unknown in Europe,—I will enumerate the remaining peculiar species which Japan possesses in common with America:—

In Japan.	*In W. N. America.*	*In E. N. America.*
Anemone Pennsylvanica		A. Pennsylvanica
(Coptis asplenifolia?)	C. asplenifolia	
(Trautvetteria palmata)	T. palmata	T. palmata
Caulophyllum thalictroides		C. thalictroides
Diphylleia cymosa		D. cymosa
Brasenia peltata	[B. peltata]	B. peltata
Geranium erianthum	G. erianthum	
Rhus Toxicodendron	R. Toxicod., var.	R. Toxicodendron
Vitis Labrusca (Thunb.)		V. Labrusca
Thermopsis fabacea	T. fabacea	
Prunus Virginiana?		P. Virginiana
Spiræa betulæfolia	S. betulæfolia	S. betulæfolia
Photinia arbutifolia, in Bonin.	P. arbutifolia	
Pyrus rivularis?	P. rivularis	
Ribes laxiflorum	R. laxiflorum	
(Penthorum sedoides, China)		P. sedoides
Cryptotænia Canadensis		C. Canadensis
Heracleum lanatum	H. lanatum	H. lanatum
(Archemora rigida?)		A. rigida
(Archangelica Gmelini)	A. Gmelini	A. Gmelini
Cymopterus littoralis?	C. littoralis	
Osmorrhiza longistylis	O. longistylis	O. longistylis
Echinopanax horridus	E. horridus	
Aralia quinquefolia		A. quinquefolia
Cornus Canadensis	C. Canadensis	C. Canadensis
Viburnum plicatum		V. plicatum (lantanoides
*Achillea Sibirica	*A. Sibirica	
*Artemisia borealis	*A. borealis	*A. borealis
Vaccinium macrocarpon	V. macrocarpon	V. macrocarpon
Menziesia ferruginea	M. ferruginea	M. ferruginea
(Boschniakia glabra?)	B. glabra	
*Pleurogyne rotata	*P. rotata	*P. rotata

In Japan.	*In W. N. America.*	*In E. N. America.*
(Asarum Canadense?)		A. Canadense
*Polygonum Bistorta	P. Bistorta	
Rumex persicarioides	R. persicarioides	R. persicarioides
Liparis liliifolia		L. liliifolia
Pogonia ophioglossoides		P. ophioglossoides
Iris setosa	I. setosa	
Trillium erectum, var.		T. erectum
(Smilacina trifolia)		S. trifolia
Polygonatum giganteum		P. giganteum
(Streptopus roseus)	S. roseus	S. roseus
Veratrum viride	V. viride	V. viride
Juncus xiphioides	J. xiphioides	
(Cyperus Iria)		C. Iria
Carex rostrata		C. rostrata
Carex stipata	C. stipata	C. stipata
Carex macrocephala	C. macrocephala	
Sporobolus elongatus	S. elongatus	S. elongatus
Agrostis scabra	A. scrabra	A. scabra
Festuca pauciflora	F. pauciflora	
Adiantum pedatum	A. pedatum	A. pedatum
Onoclea sensibilis		O. sensibilis
Osmunda cinnamomea		O. cinnamomea
Lycopodium lucidulum		L. lucidulum
(Lycopodium dendroideum)	L. dendroideum	L. dendroideum

The names enclosed in parentheses are of species which I have not seen from Japan; some of them inhabit the adjacent mainland; some are imperfectly identified. Those marked * are high northern species in America.

Of those 56 extra-European species, 35 inhabit Western, and 41 Eastern North America. And 15 are Western, and not Eastern; 21 Eastern and not Western; and 20 common to both sides of the continent. Eight or ten of these 56 species extend eastward into the interior of Asia.

On the other hand, the only species which I can mention as truly indigenous both to Japan and to Europe, but not recorded as ranging through Asia, are

Euonymus latifolius,	Fagus sylvatica,	Blechnum Spicant,
Valeriana dioica,	Streptopus amplexifolius,	Athyrium fontanum.
Pyrola media,		

Two of these species extend across the northern part of the American continent, and on to the Asiatic; another occurs on the northwest coast of America; and another, the *Fagus*, is represented in Eastern America by a too closely related species. It is noteworthy, that not one of these seven plants is of a peculiarly European genus, or even a Europæo-Siberian genus;—while of the fifty-six species of the Americo-Japanese region wanting in Europe, twenty are of extra-European genera; seven-

teen are of genera restricted to the North American, East Asian, and Himalayan regions (except that *Brasenia* has wandered to Australia); fourteen of the genera (most of them monotypic) are peculiar to America and Japan or the districts immediately adjacent; one is peculiar to our northwest coast and Japan; and eight are monotypic genera wholly peculiar (*Brasenia* excepted) to the Atlantic United States and Japan. Add to these the similar cases of other American species (nearly all of them peculiarly Atlantic-American) which have been detected in the Himalayas or in Northern Asia,—such as *Menispermum Canadense* (*Dauricum*, DC.), *Amphicarpæa monoica? Clitoria Mariana*, *Osmorrhiza brevistylis*, *Monotropa uniflora*, *Phryma leptostachya*, *Tipularia discolor?* &c.,—and it will be almost impossible to avoid the conclusion, that there has been a peculiar intermingling of the Eastern American and Eastern Asian floras, which demands explanation.

The case might be made yet stronger by reckoning some subgeneric types as equivalent to generic in the present view, and by distinguishing those species or genera which barely enter the eastern borders of Europe; e. g. *Cimicifuga fœtida*, *Mœhringia lateriflora*, *Geum strictum*, *Spiræa salicifolia*, &c.

It will be yet more strengthened, and the obvious conclusion will become irresistible, when we take the nearly allied, as well as the identical, species into account. And also when we consider that, after excluding the identical species, only 15 per cent of the entries in the European column of the detailed tabular view are in italic type (i. e. are *closely* representative of Japanese species); while there are 22 per cent of this character in the American column.

For the latter, I need only advert to some instances of such close representation, as of

Trollius patulus	by	*T. Americanus*,
Aquilegia Burgeriana	"	*A. Canadensis*,
Rhus vernicifera	"	*R. venenata*,
Celastrus scandens	"	*C. articulatus*,
Negundo cissifolium	"	*N. aceroides*,
Sophora Japonica	"	*S. affinis*,
Sanguisorba tenuifolia	"	*S. Canadensis*,
Astilbe Thunbergii & Japonica	"	*A. decandra*,
Mitchella undulata	"	*M. Repens*,
Hamamelis Japonica	"	*H. Virginica*,
Clethra barbinervis	"	*C. acuminata*,
Rododendron brachycarpum	"	*R. Catawbiense*,
Amsonia elliptica	"	*Tabernæmontana*,
Saururus Loureiri	"	*S. cernuus*,

and many others of the same sort,—several of which, when better known, may yet prove to be conspecific; while an equally

large number could be indicated of species which, although more positively different, are yet no less striking counterparts.

To demonstrate the former proposition, I have only to contrast the extra-American genera common to Europe and Japan with the extra-European genera common to North America and Japan. The principal European genera of this category are *Adonis, Epimedium, Chelidonium, Malachium, Lotus, Anthriscus, Hedera, Asperula, Rubia, Carpesium, Ligularia, Lampsana, Picris, Pœderota, Ajuga, Thymus, Nepeta, Lamium, Ligustrum, Kochia? Daphne, Thesium, Buxus, Mercurialis, Cephalanthera, Paris, Asparagus,*—to which may as well be added *Pœonia* and *Bupleurum*, the former having a representative on the mountains, and the latter in the arctic regions, of Western America, but both absent from the rest of our continent. Excepting *Pœderota* and *Buxus* (the latter a rather doubtful native of Eastern Asia), none of these genera are peculiar to Europe, but all extend throughout Asia and elsewhere over large parts of the world.

The following incomplete list of North American genera or peculiar subgeneric types represented in Japan and its vicinity, but unknown in Europe, presents a very different appearance. Those which are absent from the flora of Western North America are italicised.

Trautvetteria
Cimicifuga (barely reaches Europe)
Illicium
Magnolia
Cocculus & Menispermum
Mahonia
Caulophyllum
Diphylleia
Brasenia
Nelumbium
Dicentra
Stuartia (& Gordonia?)
Zanthoxylum
Cissus
Ampelopsis
Berchemia
Æsculus
Sapindus
Negundo
Thermopsis
Wistaria
Desmodium
Lespedeza
Rhynchosia
Sophora
Philadelphus
Penthorum
Hammelis
Liquidambar
Cryptotænia
Cymopterus?
Archemora
Osmorrhiza
Aralia & § *Ginseng*
Echinopanax
Diervilla
Mitchella
Oldenlandia
(Siegesbeckia, in Mexico)
Cacalia (reaches E. Europe)
Gaultheria
Leucothoë
Pieris
Clethra
Menziesia
Symplocos
Ardisia
Boschniakia
Catalpa
Tecoma
Dicliptera
Asarum § *Heterotropa*
Phytolacca
Benzoin & Sassafras?
Tetranthera
Saururus
Pachysandra
Laportea
Pilea
Bœhmeria
Microptelea
Maclura
Juglans
Abies § Tsuga
Chamæcyparis
Torreya
Arisæma
Arctiodracon
Pogonia
Arethusa
Dioscorea
Aletris
Coprosmanthus
Trillium
Clintonia
Streptopus § Hekorima,
Chamælirium?

Photonia	*Leptandra*	Sporobolus
Astilbe	*Callicarpa*	*Arundinaria*
Mitella	*Cedronella*	Adiantum
Hydrangea	*Amsonia*	*Onoclea*
Itea		

Here are about 90 extra-European genera or forms, 64 of which are absent from Western North America out of the tropics (the latter comprising a very large part of the most striking representative species), and almost as many more are divided between North America and extra-tropical (chiefly Northern and Eastern) Asia. About 40 of the latter are genera or groups of single, or else of two or few closely related species, peculiar, or nearly peculiar, to the regions just mentioned.

This list should be supplemented by those additional North American genera which have one or more closely representative species in the Himalayan region only, such as *Podophyllum*, *Pyrularia*, &c.; and also by the numerous cases in which Eastern American plants are represented in the Himalayo-Japanese region by strikingly cognate, although not congeneric species; such as our *Macrotys* by *Pityrosperma*; *Schizandra* by *Kadsura* and *Sphærostema*; *Neviusia* by *Kerria* and *Rhodotypus*; *Calycanthus* by *Chimonanthus*; *Cornus florida* by *Benthamia*; *Prosartes* by *Disporum*; *Helonias* by *Heloniopsis*; and so of others, which have been mentioned in the former part of this memoir, and exhibited in the accompanying tabular view.

I had long ago, in Silliman's Journal, presented some data illustrative of this remarkable parallelism, and also more recently in my "Statistics of the Flora of the Northern United States" (vol. xxii, second series); where I had noticed the facts,—1. that a large percentage of our extra-European types are shared with Eastern Asia; and 2, that no small part of these are unknown in Western North America. But Mr. Bentham was first to state the natural conclusion from all these data,—though I know not if he has even yet published the remark,—viz., that the interchange between the temperate floras even of the western part of the Old World and of the New has mainly taken place *via* Asia. Notwithstanding the few cases which point in the opposite direction (e. g. *Eriocaulon septangulare*, *Spartina*, *Subularia*, *Betula alba*), the general statement will be seen to be well sustained. Also, in the Journal of the Proceedings of the Linnæan Society, 2. p. 34, Mr. Bentham "calls to mind how frequently large American genera (such as *Eupatorium*, *Aster*, *Solidago*, *Solanum*, &c.) are represented in Eastern Asia by a small number of species, which gradually diminish or altogether disappear as we proceed westward toward the Atlantic limits of Europe; whilst the types peculiar to the extreme west of Europe (excluding of course the Arctic flora) are wholly deficient in America.

These are among the considerations which suggest an ancient continuity of territory between America and Asia, under a latitude, or at any rate with a climate, more meridional than would be effected by a junction through the chains of the Aleutian and the Kurile Islands."

I shall presently state why connection in a more meridional latitude need not be supposed.

The deficiency in the temperate American flora of forms at all peculiar to Western Europe is almost complete, and is most strikingly in contrast with the large number of Eastern American forms repeated or represented in Eastern Asia. Of genera divided between Eastern North America and Europe, I can mention only *Ostrya*, *Narthecium*, *Psamma*, the maratime *Cakile*, and perhaps *Scolopendrium*. *Hottonia* might have been added, but for a species accredited to Java. And if we extend the range across our continent, we add only *Cercis* and *Læflingia*. Of the ampler genera at all characteristic of the European flora, I can enumerate from the Flora of the Northern United States nothing more important than *Helianthemum* and *Valerianella*, two or three species of each, (but those of the former hardly congeners of the European ones,) adding that *Hieracia* and perhaps *Cirsia* are somewhat more plentiful in Eastern than in Western America. Let it also be noted, that there are even fewer Western-European types in the Pacific than in the Atlantic United States, notwithstanding the similarity of the climate!

That representation by allied species of genera peculiar, or nearly peculiar, to two regions, furnishes evidence of similar nature and of equal pertinency with representation by identical species, will hardly be doubted. Whether or not susceptible of scientific explanation, it is certain that related species of phænogamous plants are commonly associated in the same region, or are found in comparatively approximate (however large) areas of similar climate.* Remarkable exceptions may indeed be ad-

* The fundamental and most difficult question remaining in natural history is here presented;—the question whether this actual geographical association of congeneric or other nearly related species is primordial, and therefore beyond all scientific explanation, or whether even this may be to a certain extent a natural result. The only noteworthy attempt at a scientific solution of the problem, aiming to bring the variety as well as the geographical association of existing species more within the domain of cause and effect, is that of Mr. Darwin and (later) of Mr. Wallace,—partially sketched in their short papers "On the Tendency of Species to form varieties, and on the Perpetuation of Varieties and Species by natural Means of Selection," in the Journal of the Proceedings of the Linnæan Society, vol. iii. (Zoölogy), p. 45. The views there suggested must bear a prominent part in future investigations into the distribution and probable origin of species. It will hardly be doubted that the tendencies and causes indicated are really operative; the question is as to the extent of their operation. But I am already disposed, on these and other grounds, to admit that what are termed closely related species may in many cases be lineal descend-

duced, but the fact that they are remarkable goes to confirm the proposition. Indeed, the general expectation of botanists in this regard sufficiently indicates the common, implicit opinion. The discovery of a new *Sarracenia* or a new *Halesia* in the Atlantic United States, or of a new *Eschscholtzia*, *Platystemon*, or *Calais* west of the Rocky Mountains, would excite no surprise. A converse discovery, or the detection of any of these genera in a remote region, would excite great surprise. The discovery of numerous closely related species thus divided between two widely separated districts might not, in the present state of our knowledge, suggest former continuity, migration, or interchange; but that of identical species peculiar to the two inevitably would.

Why should it? Evidently because the natural supposition is that individuals of the same kind are descendants from a common stock, or have spread from a common centre; and because the progress of investigation, instead of eliminating this preconception from the minds of botanists, has rather confirmed it. Every other hypothesis has derived its principal support from difficulties in the application of this. A review of what has been published upon the subject of late years makes it clear that the doctrine of the local origin of vegetable species has been more and more accepted, although, during the same period, species have been shown to be much more widely dispersed than was formerly supposed. Facts of the latter kind, and the conclusions to which they point, have been most largely and cogently brought out by Dr. Hooker, and are among the very important general results of his extensive investigations. And the best evidence of the preponderance of the theory of the local origin of species, notwithstanding the great increase of facts which at first would seem to tell the other way,—is furnished by the works of the present De Candolle upon geographical botany. This careful and conscientious investigator formerly adopted and strenuously maintained Schouw's hypothesis of the double or multiple origin of species. But in his great work, the *Géographie Botanique Raisonnée*, published in the year 1855, he has in effect discarded it, and this not from any theoretical objections to that view, but because he found it no longer needed to account for the general facts of distribution. This appears from his qualified, though dubious, adherence to the hypothesis of a double origin, as a *dernier ressort*, in the few and extraordinary cases which he could hardly explain in any other way. His decisive instance, indeed, is the occurrence of the Eastern American *Phryma leptostachya* in the Himalaya Mountains.

ants from a pristine stock, just as domesticated races are; or, in other words, that the limits of occasional variation in species (if by them we mean primordial forms) are wider than is generally supposed, and that derivative forms when segregated may be as constantly reproduced as their originals.

The facts presented in the present memoir effectually dispose of this subsidiary hypothesis, by showing that the supposed single exception belongs to a not uncommon case. Indeed, so many species are now known to be common to Eastern and Northern Asia and Eastern North America,—some of them occurring also in Northwestern America and some not,—and so many genera are divided between these two regions, that the antecedent improbability of such occurrence is done away, and more cases of the kind may be confidently expected. However others may regard them, it is clear that De Candolle would now explain these cases in accordance with the general views of distribution adopted by him, under which they naturally fall,—so abandoning the notion of a separate creation.

I know not whether any botanist continues to maintain Schouw's hypothesis. But its elements have been developed into a different and more comprehensive doctrine, that of Agassiz, which should now be contemplated. It may be denominated the *autochthonal* hypothesis.

In place of the ordinary conception, that each species originated in a local area, whence it has been diffused, according to circumstances, over more or less broad tracts,—in some cases becoming widely discontinuous in area through climatic or other physical changes operating during a long period of time,—Professor Agassiz maintains, substantially, that each species originated where it now occurs, probably in as great a number of individuals occupying as large an area, and generally the same area, or the same discontinuous areas, as at the present time.

This hypothesis is more difficult to test, because more ideal than any other. It might suffice for the present purpose to remark, that, in referring the actual distribution, no less than the origin, of existing species to the Divine will, it would remove the whole question out of the field of inductive science. Regarded as a *philosophical* question, Maupertuis's well known "principle of least action" might be legitimately urged against it; namely, "that it is inconsistent with our idea of Divine wisdom, that the Creator should use more power than was necessary to accomplish a given end." This philosophical principle holds so strictly true in all the mechanical adaptations of the universe, as Professor Peirce has shown, that we cannot think it inapplicable to the organic world also, and especially to the creation of beings endowed with such enormous multiplying power, and such means and facilities for dissemination, as most plants and animals. Why then should we suppose the Creator to do that supernaturally which would be naturally effected by the very instrumentalities which he has set in operation?

Viewed, however, simply in its *scientific* applications to the question under consideration, (the distribution of plants in the

temperate zone of the northern hemisphere,) the autochthona hypothesis might be tested by inquiring whether the primitiv or earliest range of our species could possibly have remained unaffected by the serious and prolonged climatic vicissitudes to which they must needs have been subject; and whether these vicissitudes, and their natural consequences, may not suffice to explain the partial intermingling of the floras of North America and Northern Asia, upon the supposition of the local origin of each species. Let us bring to the inquiry the considerations which Mr. Darwin first brought to bear upon such questions, and which have been systematically developed and applied by the late Edward Forbes, by Dr. Hooker, and by Alphonse De Candolle.

No one now supposes that the existing species of plants are of recent creation, or that their present distribution is the result of a few thousand years. Various lines of evidence conspire to show that the time which has elapsed since the close of the tertiary period covers an immense number of years; and that our existing flora may in part date from the tertiary period itself. It is now generally admitted that about 20 per cent of the Mollusca of the middle tertiary (miocene epoch), and 40 per cent of the pliocene species on the Atlantic coast still exist; and it is altogether probable that as large a portion of the vegetation may be of equal antiquity. From the nature of the case, the direct evidence as respects the flora could not be expected to be equally abundant. Still, although the fossil plants of the tertiary and the post-tertiary of North America have only now begun to be studied, the needful evidence is not wanting.

On our northwestern coast, in the miocene of Vancouver's Island, among a singular mixture of species referable to *Salix*, *Populus*, *Quercus*, *Planera*, *Diospyros*, *Salisburia*, *Ficus*, *Cinnamomum*, *Persoonia*, or other *Proteaceæ*, and a Palm (the latter genera decisively indicating a tropical or subtropical climate), Mr. Lesquereux has identified one existing species, a true characteristic of the same region ten or fifteen degrees farther south, viz., the Redwood or *Sequoia sempervirens*. In beds at Somerville referred to the lower or middle pliocene by Mr. Lesquereux, this botanist has recently identified the leaves of *Persea Carolinensis*, *Prunus Caroliniana*, and *Quercus myrtifolia*, now inhabiting the warm sea-coast and islands of the Southern States.*

The pliocene quadrupeds of Nebraska also show that the climate east of the Rocky Mountains at this epoch was much warmer than now. About the Upper Missouri and Platte there were then several species of Camel (*Procamelus*) and allied Ruminantia and a Rhinoceros, besides a Mastodon, an Elephant, some Horses

* These and other data, obligingly communicated by Mr. Lesquereux, have been published in the May number of the American Journal of Science and Arts.

and their allies, not to mention a corresponding number of carnivorous animals. These herbivora probably fed in a good degree upon herbage and grasses of still existing species. For herbs and grasses are generally capable of enduring much greater climatic changes, and are therefore likely to be even more ancient than trees. These animals must have had at least a warm-temperate climate to live in: so that in lat. 40°–43° they could not have been anywhere near the northern limit of the temperate flora of those days; indeed the temperate flora, which now in Western Europe touches the Arctic Circle, must then have reached equally high latitude in Central, or Western North America. In other words, the temperate floras of America and Asia must then have been conterminous (with small oceanic separation), and therefore have commingled, as conterminous floras of similar climate everywhere do.

At length, as the post-tertiary opened, the glacier epoch came slowly on,—an extraordinary refrigeration of the northern hemisphere, in the course of ages carrying glacial ice and arctic climate down nearly to the latitude of the Ohio. The change was evidently so gradual that it did not destroy the temperate flora, at least not those enumerated above as existing species. These and their fellows, or such as survive, must have been pushed on to lower latitudes as the cold advanced, just as they now would be if the temperature were to be again lowered; and between them and the ice there was doubtless a band of subarctic and arctic vegetation,—portions of which, retreating up the mountains as the climate ameliorated and the ice receded, still scantily survive upon our highest Alleghanies, and more abundantly upon the colder summits of the mountains of New York and New England;—demonstrating the existence of the present arctic-alpine vegetation during the glacial era; and that the change of climate at its close was so gradual that it was not destructive to vegetable species.

As the temperature rose, and the ice gradually retreated, the surviving temperate flora must have returned northward *pari passu*, and—which is an important point—must have advanced much farther northward, and especially northwestward, than it now does; so far, indeed, that the temperate floras of North America and of Eastern Asia, after having been for long ages most widely separated, must have become a second time conterminous. Whatever doubts may be entertained respecting the existence of our present vegetation generally before the glacial era, its existence immediately after that period will hardly be questioned. Here, therefore, may be adduced the direct evidence recently brought to light by Mr. Lesquereux, who has identified our live oak (*Quercus virens*), Pecan (*Carya olivæformis*), Chinquapin (*Castanea pumila*), Planer-tree (*Planera Gme-*

lina), Honey-Locust (*Gleditschia triacanthos*), *Prinos coriaceus*, and *Acorus Calamus*,—besides an elm and a *Ceanothus* doubtfully referable to existing species,—on the Mississippi, near Columbus, Kentucky, in beds which Mr. Lesquereux regards as anterior to the drift. Professor D. D. Owen has indicated their position "as about 120 feet lower than the ferrugineous sand in which the bones of the *Megalonyx Jeffersonii* were found." So that they belong to the period immediately succeeding the drift, if not to that immediately preceeding it. All the vegetable remains of this deposit, which have been obtained in a determinable condition, have been referred, either positively or probably, to existing species of the United States flora, most of them now inhabiting the region a few degrees farther south.

If, then, our present temperate flora existed at the close of the glacial epoch, the evidence that it soon attained a high northern range is ready to our hand. For then followed the second epoch of the post-tertiary, called the *fluvial* by Dana, when the region of St. Lawrence and Lake Champlain was submerged, and the sea there stood five hundred feet above its present level; when the higher temperate latitudes of North America, and probably the arctic generally, were less elevated than now, and the rivers vastly larger, as shown by the immense upper alluvial plains, from fifty to three hundred feet above their present beds; and when the diminished breadth and lessened height of northern land must have given a much milder climate than the present.

Whatever the cause, the milder climate of the fluvial epoch is undoubted. Its character, and therefore that of the vegetation, is decisively shown, as geologists have remarked, by the quadrupeds. While the *Megatherium*, *Mylodon*, *Dicotyles*, &c. demonstrate a warmer climate than the present in the Southern and Middle United States, the *Elephas primigenius*, ranging from Canada to the very shores of the Arctic Ocean, equally proves a temperate climate and a temperate flora in these northern regions. This is still more apparent in the species of the other continent, where, in Siberia, not only the *Elephas primigenius*, but also a Rhinoceros, roamed northward to the arctic sea-coast. The quadrupeds that inhabited Europe in the same epoch are well known to indicate a warm-temperate climate as far north as Britain, in the middle, if not the later post-tertiary. North America then had its herds of Mastodons, Elephants, Buffaloes or Bisons of different species, Elks, Horses, *Megalonyx*, the Lion, &c.; and, from the relations between this fauna and that of Europe, there is little doubt that the climate was as much milder than the present on this as on the other side of the ocean. All the facts known to us in the tertiary and post-tertiary, even to the limiting line of the drift, conspire to show that the difference between the two continents as to temperature was very nearly the same then

as now, and that the isothermal lines of the northern hemisphere curved in the directions they now do.

A climate such as these facts demonstrate for the fluvial epoch would again commingle the temperate floras of the two continents at Behring's Straits, and earlier—propably through more land than now—by way of the Aleutian and Kurile Islands. I cannot imagine a state of circumstances under which the Siberian Elephant could migrate, and temperate plants could not.

The fluvial was succeeded by the "*terrace* epoch," as Dana names it, "a time of transition towards the present condition, bringing the northern part of the continent up to its present level, and down to its present cool temperature,"*—giving the arctic flora its present range, and again separating the temperate floras of the New and of the Old World to the extent they are now separated.

Under the light which these geological considerations throw upon the question, I cannot resist the conclusion, that the extant vegetable kingdom has a long and eventful history, and that the explanation of apparent anomalies in the geological distribution of species may be found in the various and prolonged climatic or other physical vicissitudes to which they have been subject in earlier times;—that the occurrence of certain species, formerly supposed to be peculiar to North America, in a remote or antipodal region affords of itself no presumption that they were originated there;—and that the interchange of plants between Eastern North America and Eastern Asia is explicable upon the most natural and generally received hypothesis, (or at least offers no greater difficulty than does the Arctic flora, the general homogeneousness of which round the world has always been thought compatible with local origin of the species,) and is perhaps not more extensive than might be expected under the circumstances. That the interchange has mainly taken place in high northern latitudes, and that the isothermal lines have in earlier times turned northward on our eastern, and southward on our northwest coast, as they now do, are points which go far towards explaining why Eastern North America, rather than Oregon and California, has been mainly concerned in it, and why the temperate interchange, even with Europe, has principally taken place through Asia.

Brasenia peltata.—To the remarks upon the known range of of this species, I have now to add the interesting fact, that it exists upon the northwestern coast of America, having been gathered by Dr. Pickering, in Wilkes's South Sea Exploring Expedition, in a stream which falls into Gray's Harbor, lat. 47°. It must be

* For the collocation and communication of the geological data here presented, I am indebted to the kindness of my friend, Professor Dana.

local on the western side of the continent, or it would have been met with before. When this remarkable plant was known to occur only in Eastern North America and Eastern Australia, it made the strongest case in favor of double creation that perhaps has ever been adduced. But since it has been found to occur throughout the Eastern Himalayas and in Japan, and has now been detected in Northwestern America also, the case seems to crown the conclusions to which this memoir arrives.

ART. XXI.—*Supplement to an Enumeration of North American Lichens, continued;* by EDWARD TUCKERMAN, A.M., Professor of Botany in Amherst College.

THE species follow each other, as before, in the order of the arrangement proposed by Dr. Nylander, who has studied these plants in the light afforded by a knowledge which includes not only the external, but all the microscopical details. Some species, not North American as yet known, but of more or less interest in connection with our flora, are added in brackets.

COLLEMA APALACHENSE, Tuck. in litt., thallo stellato multifido imbricato crassiusculo fusco-viridi, laciniis plano-convexis apice subteretibus obtusis rugulosis, subtus pallidis; apotheciis innato-sessilibus planis rufescentibus margine integerrimo. Sporæ ellipsoideæ 3-septatæ diam. vix duplo longiores. Lime-rocks, Hancock county, Alabama, *Hon. T. M. Peters.*

COLLEMA TEXANUM, sp. nova, thallo orbiculari substellato imbricato crasso luteo-virescente, laciniis radiantibus elongatis subplanis profunde pinnato-laceris papulosis; apotheciis sparsis planiusculis rufis margine tumido integro. Sporæ minimæ fusiformes uniseptatæ.—Trees, Texas, *Mr. Charles Wright.* Resembles the more perfect forms of C. pulposum. Spores exceedingly small. I am indebted, for their detection and delineation, to my friend, the Rev. J. L. Russell.

LEPTOGIUM CRENATELLUM, sp. nova, thallo imbricato tenerrimo glauco-cinerascente, laciniis rotundatis crenatis denticulatis; apotheciis minusculis creberrimis sessilibus convexis pallido-fuscescentibus margine tenui pallescente subintegro evanescente. Sporæ ellipsoideæ 5-septatæ.—On trees in swamps, Brattleborough, Vermont, *Mr. C. C. Frost.*

LEPTOGIUM JUNIPERINUM, Tuck. in litt., thallo pusillo suborbiculari imbricato tenui plumbeo e lobis rotundatis adscendentibus crenatis subtus ad margines albo-fibrillosis; apotheciis sesilibus plano-convexis margine tenui demum evanido discum rufo-fuscum cingente. Sporæ ellipsoideæ apicibus acutæ 3-septatæ. —On the earth in cedar woods, Texas. *Mr. Wright.*

CALICIUM CURTISII, sp. nova, thallo byssaceo nigro (vel obsoleto) apotheciis minutis turbinatis disco subnitido nigro stipitibus brevibus ex albido rufescentibus demum nigris. Sporæ majusculæ ellipsoideæ vel elongato-ellipsoideæ (dactylinæ, *Koerb.*) fuscescentes simplices.—On the living bark of Rhus typhina, in Berkshire, Massachusetts; and of Robinia Pseudacacia, at the Hot Springs, Virginia, *Rev. Dr. Curtis.* The stipes like those of Calicium or Coniocybe nigricans, Fr. (not of Tuckerm. Synops. Lich. N. E. which is C. subtile, on Bark) but the apothecia quite different, and the spores very much larger than in that species; as in C. eusporum, Nyl., to which, and C. byssaceum, Fr., the lichen is probably nearest.

BÆOMYCES ABSOLUTUS, sp. nova, thallo crustaceo effuso tenuissimo submembranaceo læteviridi; apotheciis stipitatis incarnatis planis disco demum convexiusculo marginem tenuem excludente. Sporæ ellipsoideæ simplices hyalinæ. Biatora icmadophila, var. stipitata, Tuckerm. in litt. ad cel. Montagne.—On the earth, Alabama, *Mr. Peters.* [Mountains of Cuba, *Mr. Wright.* Venezuela, *Mr. Fendler.*] Representing possibly, in tropical America, both B. ericetorum (B. roseus, Auctt.) and B. æruginosus (Biat. icmadophila, Auctt.) but nearest to the last, which it seems to connect, naturally, with the first.

[CLADONIA DACTYLOTA, sp. nova, thalli squamulis amplis erectis subtus albo-pulverulentis podetia gracilescentia cylindrica membranaceo-corticata lævigata viridi-pallescentia e margine proferentibus, scyphis angustatis margine subincurvis denticulatis demum oblique prolifero-palmatis; apotheciis carneo-fuscescentibus.

Var. *β*, *symphycarpia*, podetiis elongatis scyphis subintegris (vel obsoletis) apotheciis conglomeratis.

Var. *γ*, *sorediata*, podetiis hinc inde, scyphisque, vel his obliteratis apicibus clavatis cornutisve sorediis pulvinatis albis adspersis.—On the earth in the mountains of Cuba, *Mr. Wright.* Venezuela, *Mr. Fendler.* Differs from C. fimbriata as C. digitata differs from C. deformis. The primary form is hardly distinguishable from C. digitata, except in being whiter, and in the color of the apothecia. The white, cushion-like, powdery soredia, which, in what seems to be the commonest state, take the place of the apothecia, and are scattered over the smooth podetia (in the latter case appearing clearly to be deliquescent squamules) make perhaps the most striking, however an abnormal feature of this elegant Cladonia.]

STEREOCAULON NANODES, sp. nova, podetiis pumilis erectis cæspitoso-conglomeratis subnudis validis tereti-compressis a basi vage apicemque versus fastigiato-ramosis albidis, phyllocladiis ad apices confertis e rotundato-subsquamaceis glaucis demum

pulverulentis; apotheciis terminalibus dilatatis demum convexis. Sporæ generis. S. nanum, Tuck. Synops. N. E. p. 46, pr. p.—Rocks near water, (Crystal Falls; Saco Falls; Upper Gorge of the Ammonoosuck) in the White Mountains. S. nanum of European authors (Fr. Lich. Suec. n. 59; Schær. Lich. Helv. n. 588; Moug. and Nestl. Crypt. Vog. n. 647) appears to be an atypical condition, and has not yet occurred with us, but I have hitherto taken the present as representing the perfect state of the species. The full development of our lichen seems however to indicate a different affinity, and to separate it from the section (Chondrocaulon, Th. Fr.) which includes S. nanum. It is perhaps rather nearer to S. denudatum.

Sterocaulon chlorellum, sp. nova, podetiis pumilis erectis glabris nitidis subcompressis lacunosis stramineis fastigiato-ramosis, phyllocladiis ad apices confertis minutis rotundatis mox deliquescentibus pulverulentis; apotheciis . . . . .—Rocks, Islands of Behring's Straits, *Mr. Wright.* At once distinguishable by its minuteness, smoothness, and pale-yellow or straw color. The granules (phyllocladia, Th. Fr.) are exceedingly small. The apothecia are as yet unknown.

Stereocaulon? Wrightii, sp. nova, thallo cæspitoso cartilagineo subfoliaceo glaucescente, ramis laciniæformibus adscentibus extrorsum latioribus inciso-ramosis crenatis margine inflexis crispatis supra viridescentibus subtus nervosis tenuiter tomentosis; cephalodiis majusculis pulvinatis viridi-nigrescentibus plicato-rugosis demum floccosis; apotheciis . . . .—Rocks, Islands of Behring's Straits, *Mr. Wright.* With the habit of erect states of Squamaria chrysoleuca, but the cephalodia of Stereocaulon. It is perhaps not impossible that these little understood developments should occur outside of the present genus, or that this lichen should be *sui generis.* The crisped margins take often the shape of Parmeliaceous apothecia, thus increasing the general resemblance of the plant to a Squamaria. But it has also evident points of similarity to Stereocaulon? pulvinatum, Ach., an obscure Cape of Good Hope lichen, for specimens of which I am indebted to Dr. Sonder of Hamburg. The apothecia of this last also are unknown.

[Alectoria Japonica, sp. nova, thallo subcæspitoso tereti rigido sorediis albis exasperato stramineo, ramis sterilibus ramosissimis implexis attenuatis subfilamentosis, fertilibus simpliciusculis incrassatis, apicibus nigricantibus; apotheciis subterminalibus superficiali-sessilibus appendiculatis disco concavo demum expanso plano nitido castaneo. Sporæ majusculæ ellipsoideæ limbatæ viridi-fuscescentes demum subhyalinæ.—On dead pine trees, Ayan, Japan, *Mr. Wright.* Nearest to A. ochroleuca, but differing very much in habit, and in fructification. The spores are not very unlike those of Pertusaria pertusa.]

[RAMALINA DASYPOGA, sp. nova, thallo filamentoso rigidiusculo fragili tereti lævigato viridi-fuscescente (pallescente) ramis elongatis dichotome ramosis ultimis acuminatis nodulosis; apotheciis concavis demum planis repandis margine tenui incurvo subcrenulato disparente. Sporæ ellipsoideæ uniseptatæ curvulæ hyalinæ diam. duplo longiores.—On trees and rocks in the mountains of Cuba, *Mr. Wright.* Allied to R. usneoides (Ach.) Nyl., which has also been found in Cuba, by the same unwearied collector, but differs in its regularly terete thallus, larger apothecia, &c. It is still more like a pendulous Usnea, or perhaps Alectoria; but possesses the spores of the present genus.]

CETRARIA CALIFORNICA, sp. nova, thallo cæspitoso cartilagineo anguloso lacunoso-subcanaliculato opaco e viridi fuscescente, ramis irregulariter subdichotome ramosis patentibus, fertilibus superne incrassatis; apotheciis terminalibus appendiculatis margine dentato-fimbriatis demum convexis nigris.—On the bark of trees, Monterey, California, *Menzies.* Fronds in small, roundish masses, many branches diverging from a single base, with the aspect rather of a small, slender state of Ramalina calicaris, *β*, than of the erect Cetrariæ, to which, and in particular C. tristis and C. aculeata, it is indeed, if I mistake not, nearest allied. The station, upon trees, and on the coast of California, is a very unlikely one for C. aculeata, from which the present also differs remarkably in habit of growth, and in color. Though more than seventy years have passed since the venerable botanist who gave me these specimens collected them, they appear to be undescribed.

STICTA RAVENELII, sp. nova, thallo pusillo suborbiculari membranaceo appresso scrobiculato viridi-glaucescente (fuscescente) laciniis elongatis sinuato-lobatis crenatis (glomerulis fruticulosis viridibus nunc aspersis) subtus fuscescentibus tomentosis; apotheciis sparsis margine inflexo persistente crenulato-sublobato. Sporæ elongato-fusiformes 1–3-septatæ virescentes diam. 12–20-plo longiores.—Trees, in the low country of South Carolina, *Mr. Ravenel;* Alabama, on trees, *Mr. Peters;* and also on rocks (the specimen dark brown), *Mr. Beaumont;* Mississippi, *Dr. Veitch;* Louisiana, *Dr. Hale;* (Cuba, *Mr. Wright.*)—A smaller plant than either of the two species of this group, of the northern hemisphere, with much the lobation of S. glomerulifera, but the texture of S. herbacea, and distinguished, so far as my specimens go, from both, by its strongly pitted upper surface, and its crenulate-lobate apothecia, which rather approach those of some of the tropical members of the group, as S. pallida, Hook. The glomerules appear only on a Cuban specimen. They are quite like those of S. glomerulifera, but the largest do not exceed a line in diameter. The spores are more elongated than those of the species just mentioned, and appear to be differently septate.

[Sticta Wrightii, sp. nova, thallo subcoriaceo adpresso lævigato viridi-glaucescente, laciniis rotundatis sinuato-incisis crenatis subtus fuscis ambitu pallescentibus tomentosis, cyphellis plano-concavis albis; apotheciis sparsis elevatis extus mammillatis e concavo margine inflexo demum planis margine irregulari subevanescente. Sporæ late fusiformes uniseptatæ limbatæ virescentes diam. c. 5-plo longiores.—On beech trunks, mountain sides, Hakodadi, Japan, *Mr. Wright.* With the apothecia, and the general aspect of S. glomerulifera, but differing in a rather more loose habit of lobation, it which it approaches nearer to the broader forms of S. damæcornis; in its spores; and most remarkably, in possessing in abundance, regular cyphellæ; which resemble those of S. fuliginosa, though also occurring urceolate, as in S. damæcornis. The genus Ricasolia, De Not., was originally constituted, to include the natural group of species to which the present belongs, on a mistaken comparison of the apothecia of these species, with certain abnormal apothecia common in other species of Sticta, which are now regarded, since the publication of Mr. Tulasne's important researches, as morbid conditions, infested by a parasitic cryptogam. (Tulasne, Mém. sur les Lichens, p. 123, note.) The species included in the group, agreeing as they do in many obvious features, were also once supposed to be destitute of cyphellæ, and the greater part, and in particular, the tropical ones, probably are so; but Fries and Delise testify to the occurrence of this development, however rarely, in both the old species of the northern hemisphere, while in the Japanese lichen, above-described, it is normal. This species may not improbably be found to occur also in North America.]

[Physcia? Wrightii, sp. nova, thallo orbiculari imbricato tenui molliusculo polito pallide viridi (glaucescente) subtus albo venis minusculis prominulis villosis reticulato, hypothallo nunc crassiusculo byssaceo-lanuginoso cinerascente, laciniis planis irregulariter multifido-lacinulatis, ambitu latioribus palmatis, centro plus minus excrescentiis isidiomorphis cylindricis obsitis; apotheciis subcentralibus sessilibus disco plano luteolo margine crasso incurvo crenulato cincto demum flexuosis. Sporæ . . . .—On trunks of trees in dense woods, in the mountains of Cuba, *Mr. Wright.* With the habit of Physcia, but also a good deal resembling Parmelia ambigua. The species appears to be undescribed.]

Lecanora Ascociscana, Tuck. herb. Psoroma, Tuckerm. suppl. &c. in Amer. Journ. Sci., xxv, p. 424. There is something in this curious lichen which suggests a near affinity to Psoroma, as the genus is constituted by Dr. Nylander, but the fuscescent, often a little curved and kidney-shaped, one-septate

spores indicate its true place in Lecanora, where it long stood in my herbarium. The spores resemble those (I owe the suggestion to Dr. Nylander) of L. sophodes, but the lichen is very distinct.

[LECANORA CAMPALEA, sp. nova, thallo crustaceo tartareo verrucoso-subplicato lævigato viridi-glaucescente (pallescente) hypothallo nigro insigni limitato; apotheciis appressis demum flexuoso-irregularibus disco tumente e rufo fusco-nigrescente margine thallode integro pallente. Sporæ suboctonæ elongato-fusiformes 5-pluriseptatæ diam. 10–15 plo longiores hyalinæ.—Trees, Island of Cuba, *Mr. Wright.* The affinity of this elegant lichen to L. ventosa is indicated, no less by the spores than by the external characters.]

[BIATORA RHODOPIS, sp. nova, thallo crustaceo effuso tenui cartilagineo-membranaceo lævigato rimuloso limitato glauco-cinerascente, intus miniato; apotheciis sessilibus hinc inde aggregatis demum difformibus margine tumidulo integerrimo lævi mox flexuoso saturate roseo discum subplanum nudum rufo-nigrescentem hypothecio crassiusculo nigro impositum cingente. Sporæ suboctonæ ellipsoideæ simplices diam. duplo longiores hyalinæ. —On bushes in the Island of Cuba, *Mr. Wright.* Differs remarkably from described species, but has somewhat of the general aspect of L. domingensis.

BIATORA VIRELLA, sp. nova, thallo crustaceo effuso incrustante subtartareo rugoso-granulato glauco-sulphureo, humecto viridi; apotheciis sessilibus margine tenui pallidiori integerrimo mox flexuoso evanido discum planoconvexum rufo-fuscescentem cingente. Sporæ minusculæ ellipsoideæ subfusiformes diam. triplo longiores hyalinæ.—On rocks in dense woods, in the mountains of Cuba, *Mr. Wright.* With the habit of L. glebulosa.

BIATORA PYRRHOMELÆNA, sp. nova, thallo e granulis minutis rotundatis mox subsquamaceis imbricatis glaucescentibus intus miniatis hypothallum crassum rufo-nigricantem ad ambitum prominentem interrupte obtegentibus; apotheciis ex hypothallo oriundis subplanis margine tenuissimo erecto flexuoso rufo-nigrescente discum nigrum nitidum hypothecio rufo impositum cingente, dein conglomeratis convexis marginem excludentibus. Sporæ minutæ ellipsoideæ simplices hyalinæ.—On trunks of trees near the ground, in the mountains of Cuba, *Mr. Wright.* Near to B. parvifolia, but differing as described.

BIATORA PHÆASPIS, sp. nova, thallo crustaceo effuso e granulis subsquamaceis mox corallinis pallide ochroleucis; apotheciis appressis rufo-fuscis flexuosis disco demum convexo marginem obtusum pallidiorem excludente. Sporæ fusiformi-cylindricæ 1–4-septatæ diam. 3–4-plo longiores hyalinæ.—Trees, Cuba, *Mr. Wright.* Also resembling B. parvifolia in general appearance,

but the spores connect the lichen rather with B. vernalis. It does not appear to be described.]

GYROSTOMUM CURTISII, Tuckerm. suppl. in Amer. Journ. Sci., XXV, p. 430, a determination made upon high authority, is referred by my friend Mr. Russell to Lecidea; and the spores, as his sketch fully shows, indicate that the lichen is probably only a small form of L. disciformis (L. parasema, Fr. *a*) in which the apothecia are a little urceolate. G. urceolatum is also referred to Lecidea by Dr. Nylander (Enum. Gen., p. 127) but seems to me to be remarkably distinguished by the structure of the apothecium, and the vermicular spores.

ART. XXII.—*On the Phenomena of Gemmation.—Lecture before the meeting of the Royal Institution of Great Britain, by* THOMAS H. HUXLEY, F.R.S.*

THE speaker commenced by stating that a learned French naturalist, M. Duvau, proposed many years ago, to term the middle of the eighteenth century, "l'Époque des Pucerons:" and that the importance of the phenomena which first brought to light by the study of these remarkable insects renders the phrase "Epoch of Plant-lice," as applied to this period, far less whimsically inappropriate than it might at first sight seem to be.

After a brief sketch of the mode of life of these Plant-lice, or *Aphides*, as they are technically termed; of the structure of their singular piercing and sucking mouths; and of their relations to what are called "Blights;" the circumstances which have more particularly drawn the attention of naturalists to these insects were fully detailed.

It was between the years 1740 and 1750, in fact, that Bonnet, acting upon the suggestions of the illustrious Reaumur, isolated an *Aphis* immediately after its birth, and proved to demonstration, that not only was it capable of spontaneously bringing forth numerous living young, but that these and their descendants, to the ninth generation, preserved a similar faculty.

Observations so remarkable were not likely to pass unheeded; but notwithstauding the careful sifting which they have received, Bonnet's results have never been questioned. On the contrary, not only have Lyonet, Degeer, Kyber, Duvau, and others, borne ample testimony to their accuracy, but it has been shown that, under favorable conditions of temperature and food, there is practically no limit to this power of a sexual multiplication, or as it has been conveniently termed, "Agamogenesis."

* From the Proceedings of the Royal Institution of Great Britain, May, 1858,

Thus Kyber bred the viviparous *Aphis Dianthi* and *Aphis Rosæ* for three years in interrupted succession; and the males and true oviparous females of the *A. dianthi* have never yet been met with. The current notion that there is a fixed number of broods, "nine or eleven," is based on a mistake.

As, under moderately favorable conditions, an *Aphis* comes to maturity in about a fortnight; and as each *Aphis* is known to be capable of producing a hundred young, the number of the progeny which may eventually result from a single *Aphis* during the six or seven warm months of the year is easily calculated. M. Tougard's estimate adopted, (and acknowledged) by Morren, and copied from him by others, gives the number of the tenth brood as one quintillion. Supposing the weight of each *Aphis* to be no more than $\frac{1}{1000}$th of a grain, the mass of living matter in this brood would exceed that in the most thickly populated countries in the world.

The agamogenetic broods are either winged or wingless. The winged forms at times rise into the air, and are carried away by the wind in clouds; and these migrating hordes have been supposed to be males and females, swarming like the ants and bees! During the summer months it is unusual to meet other than viviparous *Aphides*, whether winged or wingless; but ordinarily, on the approach of cold weather, or even during warm weather, if the supplies of food fall short, the viviparous *Aphides* produce forms which are no longer viviparous, but are males and oviparous females. The former are sometimes winged, sometimes wingless. The latter, with a single doubtful exception, are always wingless.

The oviparous females lay their eggs, and then, like the males, die. It commonly happens also that the viviparous *Aphides* die, and then the eggs are left as the sole representatives of the species; but in mild winters many of the viviparous *Aphides* merely fall into a state of stupor and hybernate, to re-awake with the returning warmth of spring. At the same time the eggs are hatched and give rise to viviparous *Aphides*, which run through the same course as before. The species *Aphis*, therefore, is fully manifested not in any one being or animated form, but by a cycle of such, consisting of,—1st. the egg; 2nd, An indefinite succession of viviparous *Aphides;* 3rd, Males and females eventually prodeced by these, and giving rise to the egg again.

If, armed with the microscope and scalpel, we examine into the minute nature of these processes (without which inquiry all speculation upon their nature is in vain), we find that the viviparous *Aphis* contains an organ similar to the ovarium of the oviparous female, in some respects, but differing from it, as Von Siebold was the first to show, in the absence of what are termed

the colleterial glands and the spermatheca—organs of essential importance to the oviparous form.

In the terminal chambers of this "Pseud-ovarium," ovum-like bodies, thence called "pseud-ova," are found. These bodies pass one by one into the pseudovarian tubes, and there gradually become developed into young, living *Aphides*. As Morren has well said, therefore, the young *Aphides* are produced by "the individualization of a previously organized tissue."

The only organic operation with which this mode of development can be compared, is the process of budding or gemmation as it takes place in the vegetable kingdom, in the lower forms of animal life, and in the process of formation of the limbs and other organs of the higher animals. And the parallel is complete if such a plant as the bulbiferous lily or the *Marchantia*, or such an animal as the *Hydra*, is made the term of comparison.

Thus agamogenesis in *Aphis*, is a kind of internal budding or gemmation. If we inquire how this process differs from multiplication by true ova or "Gamogenesis," we find that the young ovum in the ovarium is also, to all intents and purposes, a bud, indistinguishable from the germ in the pseudovarium of the agamogenetic *Aphis*. Histologically there is no difference between the two; but there is an immense qualitative or physiological difference, which cannot be detected by the eye, but becomes at once obvious in the behavior of the two germs after a certain period of their growth. Dating from this period, the pseudovum spontaneously passes into the form of an embryo, becoming larger and larger as it does so; but the ovum simply enlarges, accumulates nutritive matter, acquires its outer investments, and then falls into a state of apparent rest, from which it will never emerge, unless the influence of the spermatozoon have been brought to bear upon it.

That the vast physiological difference between the ovum and the pseudovum should reveal itself in the young state by no external sign, is no more wonderful than that primarily the tissue of the brain should be undistinguishable from that of the heart.

The phenomena which have been described, were long supposed to be isolated, but numerous cases of a like kind, some even more remarkable, are now known.

Among the latter, the speaker cited the wonderful circumstances attending the production of the drones among bees, as described by Von Siebold; and he drew attention to the plant upon the table, *Œlobogyne ilicifolia*, a female euphorbiaceous shrub, the male flowers of which have never yet been seen, and which nevertheless, for the last twenty years, has produced its annual crop of fertile seeds in Kew Gardens.

Not only can we find numerous cases of agamogenesis similar to that exhibited by *Aphis* in the animal and vegetable worlds,

but if we look closely into the matter, agamogenesis is found to pass by insensible gradations into the commonest phenomena of life. All life, in fact, is accompanied by incessant growth and metamorphosis; and every animal and plant above the very lowest attains its adult form by the development of a succession of buds. When these buds remain connected together, we do not distinguish the process as anything remarkable; when on the other hand, they become detached and live independently, we have agamogenesis. Why some buds assume one form and some another, why some remain attached and some become detached, we know not. Such phenomena are for the present the ultimate facts of biological science; and we cannot understand the simplest among them, it would seem useless, as yet, to seek for an explanation of the more complex.

Nevertheless, an explanation of agamogenesis in the *Aphis* and in like cases has been offered. It has been supposed to depend upon "the retention unchanged of some part of the primitive germ-mass;" this germ-mass being imagined to be the seat of a peculiar force, by virtue of which it gives rise to independent organisms.

There are however two objections to this hypothesis: in the first place, it is at direct variance with the results of observation; in the second, even if it were true, it does not help us to understand the phenomena. With regard to the former point, the hypothesis professes to be based upon only two direct observations, one upon *Aphis*, the other upon *Hydra;* and both these observations are erroneous, for in neither of these animals is any portion of the primitive germ-mass retained, as is said to be, in that part which is the seat of agamogenesis.

But suppose the fact to be as the hypothesis requires; imagine that the terminal chamber of the pseudovarium is full of nothing but "unaltered germ-cells;" how does this explain the phenomena? Structures having quite as great a claim to the title of "unaltered germ-cells" lie in the extremities of the acini of the secreting glands, in the sub-epidermal tissues and elsewhere; why do not they give rise to young? Cells, less changed than those of the pseudovarium of *Aphis*, and more directly derived from the primitive germ-mass, underlie the epidermis of one's hand; nevertheless, no one feels any alarm lest a nascent wart should turn out to be an heir.

On the whole, it would seem better, when one is ignorant, to say so, and not to retard the progress of sound inquiry by inventing hypotheses involving the assumption of structures which have no existence, and of "forces" which, their laws being undetermined, are merely verbal entities.

Art. XXIII.—*On Earthquakes in Southern Italy, by* James Philip Lacaita, Esq., LL.D.*

Southern Italy is celebrated for its delightful climate, its matchless scenery, its great historical associations; but it has also a less enviable renown; it is the classic ground of volcanoes and earthquakes. Etna and Vesuvius are the two most active volcanoes in Europe, and terrific earthquakes have often desolated vast districts of the country.

Though the common origin, to a certain extent, of the agents producing the phenomena of volcanoes and earthquakes is now scarcely questioned, considerable difference of opinion still prevails with regard to the real nature and character of those agents. It is for men of science to determine whether those agents are to be found in the internal heat of the earth which is supposed to arise from a state of fusion; or in the heat produced by chemical combinations and changes; or in the currents of electricity circulating on the earth's crust; or in any other causes whatsoever. On this *vexata quæstio* much light will no doubt be thrown before long by the observations made on the spot by Mr. Mallet, the distinguished author of the "Dynamics of Earthquakes," who, on the first news of the late earthquake in Southern Italy in December last, was sent thither by the Royal Society, for the pursuit of scientific enquiry. Without entering, however, into the field of science, the object of the speaker was to give the members of the Royal Institution a short account of six great earthquakes, without counting minor ones, which within the memory of man laid waste extensive tracts of the kingdom of Naples and caused great loss of life; and especially of the last earthquake, which took place on the night of the 16th of December, 1857.

1. On the 5th of February, 1783, at 1 P. M., the Piana di Monteleone, in the province of Calabria Ultra I, was convulsed by a violent shock of earthquake, which in less than two minutes levelled to the ground 109 towns and villages, and buried 32,000 out of 166,000 inhabitants under the ruins of their houses. A repetition of the shock at midnight ruined the towns of Reggio and Messina, and convulsed the whole Valdemone. At the entrance of the Faro Straits, the sea, retiring from the Calabrian shore and afterwards rushing back with overwhelming violence, swept away more than 1500 inhabitants of the town of Scylla, who had taken refuge on the beach for safety. After a succession of slight shocks, on the 28th of the following March, another violent shock convulsed the whole country from Reggio to Cape Colonna, an area of 1200 square miles, and added two

* From the Proceedings of the Royal Institution of Great Britain, May, 1858.

thousand more to the number of victims. Mountains were cleft asunder, high cliffs tumbled down, rivers turned from their bed or dammed in their course, lakes formed, valleys lifted up into hills, deep chasms opened, the physical aspect of the country changed, all distinctions of property altered. For twenty days a thick pestilential fog set over the desolated country; epidemic fevers followed in summer; and at the beginning of 1784 Calabria had already lost more than 80,000 inhabitants. From February to December 1783, there were no less than 949 shocks, and 151 in 1784; they did not altogether cease till 1786.

2. The mountain of Frosolone, in the province of Molise, the ancient *Samnium*, on the 26th of July, 1805, at 10½ P. M., was the centre of a violent shock of earthquake, which lasted 35 seconds, and caused great desolation over an area of 600 square miles. It ruined 61 towns and villages, and crushed to death more than 6000 people. It was severely felt as far as Naples, where all the buildings were greatly injured by its effects.

3. On the 29th of April, 1835, and on several successive days, the Val di Crati, in the province of Calabria Citra, including the town of Cosenza and its numerous villages, was convulsed by violent shocks of earthquake, which caused the death of more than 1000 people under the ruins.

4. On the 12th of October, 1836, the districts of Rossano and Castrovillari, in the same province, and the district of Lagonegro, in Basilicata, felt another violent shock of earthquake, which swept away more than 600 inhabitants.

5. The city of Melfi, built on a spur of Mount Vulture, an extinct volcano in the province of Basilicata, on the 14th of August, 1851, was the focus of a violent earthquake, which, besides Melfi itself, ruined Barile, Rapolla, and many other towns, and was felt as far as Naples on the western, and Brindisi on the eastern coast. The first shock, at 2 P. M., lasted 20 seconds; the second shock, at 3 P. M., lasted only five seconds. The loss of human life exceeded 1400; Melfi alone, out of 9274, lost 1093 inhabitants.

6. But worse than any of the latter earthquakes, and second only to the Calabrian one of 1783, was the earthquake which took place on the 16th of December last, at 10¼ P. M., at a season of the year, which, by a comparison of all the known dates of earthquakes, has been ascertained to be more subject to disturbances than any other. The sky was clear, the air still; indeed unusual stillness had prevailed the whole of that day. A sharp undulatory shock of 20 seconds' duration, immediately preceded and accompanied by an appalling hollow rumbling noise, had scarcely awaked the inhabitants, who, according to the early habits of provincial life had already retired to rest, when after a hardly perceptible pause of about three minutes, a second and

most violent successive and whirling shock of 25 seconds' duration crushed thousands of them under the ruins of their falling houses. Three other shocks were felt on that awful night, and many others on the following days; but none nearly so violent and so destructive as the two former ones. For nearly two months a slight shock was felt almost periodically just before sunrise. On the 7th of March, about 3 P. M., a violent shock, second only to those of the 16th of December, was felt, which caused considerable injury; and, according to the latest accounts, up to the 28th of April last, the shocks, though comparatively slight and harmless, still continued, and the people were in a state of constant alarm. Such was also the case in every one of the five previous earthquakes that have been noticed; the violence of the hidden agents at work was not at once exhausted by the first great shocks, but continued slightly to shake the ground for months, and sometimes, as in the Calabrian earthquake of 1783, for nearly four years afterwards.

The seat of this earthquake was in the central group of mountains in the provinces of Basilicata and Principato Citra, part of the main chain of the Apennines, which are the watershed between the streams flowing into the Tyrrhenian, the Ionian, and the Adriatic sea, and form the upper basins of the Calore or Tanagro, the Sele, the Ofanto, the Bradano, the Basento, the Sinno, and the Agri rivers. The centre of action, as far as it can be judged from the intensity of its terrific effects, was almost in the heart of the province of Basilicata, in a group of compact limestone mountains of the cretaceous period, the southern branch of the said central group, which running from north to south between the heads of the valleys of the Sinno and the Agri on the east, and the valley of Diano on the west, swells farther south into the lofty peaks of Monte Cocuzzo, Monte del Papa, and Monte Pollino, on the frontiers of Calabria. On the declivities or lower peaks of this group, which are covered with beds of tertiary marine marl sands and conglomerate, and within a district extending over an area of about 216 square miles, stand, or rather stood, the towns and villages of Montemurro, Saponara, Viggiano, Tramutola, Marsico Vetere, Marsico Nuovo, Spinosa and Sarconi, with an aggregate population of 35,570. Out of this number more than 12,000, or more than one-third, in less than half a minute were crushed to death; two thousand severely wounded! The ground was cracked and convulsed in the strangest manner; chasms and deep fissures were opened in several places, fertile hills became bare rocks, valleys were raised up, small pools formed, mountains cleft by deep ravines. The towns of Montemurro and Saponara especially were nearly entirely swept away; the former lost 5600 out of 7000, and the latter 3000 out of 4000 inhabitants. Saponara, which rose in

the middle ages out of the ancient *Grumentum*, where Hannibal sustained a slight defeat by the Consul Claudius Nero, was almost entirely levelled with the ground; there remain only a few shattered houses standing. Of Montemurro, originally a Saracenic settlement of the tenth century, literally nothing was left but a heap of rubbish. On the morning of the 17th of December, 5600 of its inhabitants were dead or dying under the ruins, 685 disabled by wounds; the few remaining unhurt found themselves torn from their dearest ones, houseless, amidst a mass of ruins, without means of subsistence or help, and exposed to all the inclemency of a severe winter on a high peak of the Apennines! A few days later the stench of the dead human beings under the ruins made life unbearable to the few surviving ones! Both at Montemurro and Saponara, most of the houses standing on beds of conglomerate had been overturned, or shuffled in the strangest manner, and the ruins deposited in the ravines beneath; the contents of the lower stories were, in several instances thrown up into the stories above, or scattered into different directions, as if propelled by a central force. The scenes of misery and horror that took place in those doomed towns exceed what imagination can fancy. Viggiano came next, a town whose inhabitants from time immemorial have been in the habit of wandering, with their harps over different parts of the world, and return home with their savings in summer. It lost 1700 out of 6634 inhabitants, and had most of the houses and churches overthrown. At this place an extensive fire added to the horrors of the night.

From the centre of a triangle formed by these three towns, on which the fury of the convulsion was more violently wreaked, the distances, in a direct line, are,—to the Gulf of Policastro, 24 miles; to Pæstum, on the Gulf of Salerno, 58 miles; to the mouth of the Agri, on the Gulf of Tarentum, 47 miles; to the extinct volcano of Mount Vulture, 55 miles; to Mount Vesuvius, 94 miles; to Bari, on the Adriatic, 80 miles; and to Mount Etna, 195 miles.

Beyond this district, the terrific effects of the earthquake extended, though somewhat diminished in intensity, over an area of more than 3000 square miles, destroying or injuring, more or less, about 200 towns and villages, with an aggregate population of more than 200,000 inhabitants, of whom no less than 10,000 were killed.

Within this area the beautiful and fertile valley of Diano, through which flows the Tanagro, a tributary of the Sele, traversed in its length by the high road leading into Calabria, and enlivened on both sides by numerous towns and villages built on the top or the slope of the hills, was sadly desolated. Polla is said to have lost 2000 out of 7060 inhabitants; Padula, 500

out of 9000; Pertosa, 218 out of 1100; Sassano, 185 out of 3600; Montesano, 420 out of 4800, &c. Leaving the valley of Diano, and proceeding northwards to the head of the vallley of the Sele, will be found Brienza, Calvello, St. Angelo Le Fratte, Picerno, Tito, Potenza, the capital of Basilicata, etc., with most of their houses and public buildings ruined, and many of their inhabitants killed. At Tito, in particular, more than 300 out of 4939 inhabitants were crushed to death, and its beautiful Norman cathedral totally thrown to the ground. South of Potenza, in the upper valleys of the Bradano, the Basento and the Agri, and eastward of the center of action, Laurenzana, Corleto, Guardia, Aliano, Armento, Gallicchio, Missanello, Sant' Arcangelo, Castelsaraceno, and numerous other towns and villages, had most of the houses thrown down, and many inhabitants killed.

But the effects of this terrific earthquake extended far beyond the large era that has just been noticed. The two shocks of the 16th were felt, with various degrees of intensity, as far as the town of Reggio in Calabria on the south, Brindisi on the Adriatic, on the east, Vasto, also on the Adriatic, on the north, and Terracina on the west. Within these limits many towns had their buildings much injured, and some inhabitants killed. All the towns on the Adriatic, from Polignano to Manfredonia, had their buildings rent. At Canosa, 15 houses were thrown down, 155 more rendered uninhabitable, and 5 persons were killed. At Melfi and Barile, there were three deaths. In the neighborhood of Bella, a town which stands half way between Potenza and Melfi, a tract of about 600 acres was split in different directions, and surrounded with a chasm 15 feet deep, and about as wide. At Salerno, many public buildings were injured, and 4 persons killed. Even at Tramonti, near Amalfi, there were two deaths; and at Naples, the inhabitants were so greatly alarmed by the violence of the shocks, as to spend in the open air all the night of the 16th of December.

On the whole, by this terrific earthquake, at least 22,000 human beings, on a most moderate calculation, were destroyed in a few seconds. Many no doubt would have been saved had it been possible by active steps to dig them out immediately. This will account for the comparatively very small number of wounded, in all about 4000.

From the above data it will be seen that in the course of 75 years, from 1783 to 1857, the kingdom of Naples lost at least 111,000 inhabitants, by the effects of earthquakes, or more than 1500 per year, out of an average population of six millions!

Several touching anecdotes were told in the course of the narrative. In 1783, Eloisa Basili, a beautiful girl of 16, was buried under the ruins with a child in her arms, who died on the fourth

day. She was so wedged in that she could not get rid of its lifeless remains. She was dug out alive after eleven days, which she had counted from a ray of light that reached her. She recovered, but remained sad and gloomy, could not bear to see a child, would neither marry nor become a nun. She preferred solitude, turned away with a shudder from houses, and liked to sit musing under a tree, whence no buildings were seen. She pined away, and died at five-and-twenty.

More fortunate was the lot of Marianna De' Franceschi, a beautiful young lady of 20, who, in the earthquake of 1804, was dug out at Guardia Regia, after being buried for ten days and eight hours. She recovered, married, and became the mother of a numerous family.

A lady with child was dug out after 30 hours by her devoted husband, who nearly died from over-fatigue. On being asked what her thoughts were during the time, she answered, "I was waiting."

In the late earthquake, a gentleman of Montemurro, whilst escaping from the house with his wife and a large family of children, remembered that one of them had been left in bed. He rushed back to take him, but the house tumbling on every side, he remained alone on a wall. All his family were crushed to death. The blow was too great; his mind gave way, and he went raving mad. At Saponara, the judge was buried under the ruins of his house with his young wife and two children. He was dug out alive, but his wife was found dead lying across his knees with her arms outstretched towards her dead children. He was overwhelmed by his loss; ever since he has diligently fulfilled the duties of his office, but has never been heard to allude to the event, or seen to smile.

Instances were mentioned, showing how tenacious life could be under the most trying circumstances. Besides the cases of Basili and De' Franceschi already recorded, in 1783 a baby was dug out alive on the third day, and lived. At Montemurro, in December last, Maria Antonia Palermo and her two little girls, one of them only thirteen months old, were dug out on the eighth day, and lived. With some animals the length of time they had stood alive was quite remarkable. A donkey was found living yet on the fifteenth day; and in 1783 two mules and a chicken were found still alive on the twenty-second, and two pigs on the thirty-second day.

ART. XXIV.—*Notes on some of the Chemical Reactions of Strychnia;* by T. G. WORMLEY, M.D.

IN the following paper it is proposed to give the result of some experiments in regard to the relative value of the various tests which have been suggested for the detection of strychnia.

The various solutions were made with great care from pure strychnia dissolved in just sufficient quantity of acetic acid, and the reagents were generally applied by means of a glass rod dipped in a saturated solution of the reagent, to a *single drop* of the strychnia solution delivered, upon a glass slide, from a graduated burette which furnished a fluid grain in each drop. Therefore, each drop contained an amount of pure strychnia, corresponding to the fractional dilution of the solution.

1. *Ammonia Test.*

1. $\frac{1}{1000}$ grain of pure strychnia in one grain of water, gives with ammonia, an immediate white precipitate, which at first is amorphous, but very soon it begins to assume a crystalline form, and in about three minutes the drop becomes a solid mass of lengthened prisms.

2. $\frac{1}{2000}$ gives an immediate precipitate, but in a few seconds beautiful stellate crystals begin to form, which very soon become abundant.

3. $\frac{1}{3000}$, behaves much the same as No. 2, not so abundant.

4. $\frac{1}{4000}$, with the microscope, crystals begin to form in about a minute, in three minutes they are very obvious to the naked eye. If the drop be rubbed with a glass rod, rings of granules are very obvious to the eye in a few seconds, and the precipitate is much more abundant than when not thus treated.

5. $\frac{1}{5000}$, no indications after stirring for several minutes, except when viewed with the microscope, a few granules appear.

From the above experiments, the limit of the ammonia test, when applied to a single drop, is when it holds in solution $\frac{1}{2500}$ its weight of strychnia; however, at this degree of solution the result is very satisfactory.

2. *Potash.*

This reagent behaves much the same as ammonia, its limit being about the same. In applying this test it is important that the proper quantity be added, for if either too much or to little, no precipitate will be produced.

3. *Carbonate of Potash.*

1. $\frac{1}{1000}$ grain of strychnia with carbonate of potash gives an immediate white precipitate of star-like crystals, which will redissolve if sufficient quantity of the reagent has not been added.

2. $\frac{1}{5000}$, in a few seconds small granules, prisms, and a few stellate crystals begin to form, which after a little time are rather abundant.

3. $\frac{1}{10000}$, in a few seconds lengthened granules may be seen with the microscope, which in a few minutes are very obvious to the naked eye.

4. $\frac{1}{25000}$, after a few minutes small granules are very perceptible.

5. $\frac{1}{50000}$, after several minutes no indications with the microscope.

4. *Carbonate of Ammonia.*

In $\frac{1}{100}$, and $\frac{1}{500}$ solutions the same results as with carbonate of potash. In a drop of $\frac{1}{1000}$ solution no indication after 15 minutes.

5. *Iodid of Potassium.*

1. $\frac{1}{100}$ solution in a few seconds gives a white crystalline precipitate of tufts of long prisms.

2. $\frac{1}{500}$, it is several minutes before crystals begin to form, if the solution be stirred, however, they begin to appear in about two minutes.

3. $\frac{1}{1000}$, by stirring, the crystals begin to appear in about five minutes.

4. $\frac{1}{2500}$, crystals begin to form in about seven minutes.

5. $\frac{1}{5000}$, crystals can be observed with the microscope in about 10 minutes, in 20 minutes they are just perceptible to the naked eye.

6. *Sulphocyanid of Potassium.*

1. $\frac{1}{100}$, solution, gives an immediate mass of white crystals.

2. $\frac{1}{500}$, in a few seconds the crystals are very abundant.

3. $\frac{1}{2500}$, by rubbing, in less than a minute the crystals are very obvious.

4. $\frac{1}{1000}$, by rubbing, in a few minutes the crystals begin to form.

5. $\frac{1}{5000}$, no indication after several minutes, with the microscope a few crystals may be observed upon the border of the drop.

7. *Tannic Acid.*

1. $\frac{1}{100}$, $\frac{1}{5000}$, gives an immediate white curdy precipitate.

2. $\frac{1}{250}$, $\frac{1}{5000}$, gives very good results.

3. $\frac{1}{500}$, $\frac{1}{5000}$, after a few minutes the precipitate is quite perceptible.

4. $\frac{1}{400}$, $\frac{1}{5000}$, after several minutes it is just possible to observe a white cloudiness.

The satisfactory limit of the test is when it is applied to a drop of fluid holding in solution $\frac{1}{333}$, $\frac{1}{5000}$ its weight of strychnia.

The precipitate is very soluble in acetic acid, and if obtained from dilute solutions, it is, also, soluble in a drop of potash, giving a red liquid; but when produced from strong solutions, the precipitate will not all dissolve in a drop of potash solution.

8. *Bichlorid of Platinum.*

1. $\frac{1}{100}$, an immediate yellow amorphous precipitate which soon becomes granular.

2. $\frac{1}{300}$, an amorphous precipitate in a few moments, which soon becomes granular.

3. $\frac{1}{500}$, the results are very good in a few minutes.

4. $\frac{1}{100}, \frac{1}{600}$, if the solution be rubbed, small granules begin to appear in a few minutes, and soon the result is satisfactory.

9. *Terchlorid of Gold.*

1. $\frac{1}{100}$, gives a bright yellow amorphous precipitate, which soon becomes partly granular; most of the granules float upon the surface of the drop. A portion of the precipitate collects into little yellow flakes.

2. $\frac{1}{300}$, gives much the same reaction as No. 1, not so abundant.

3. $\frac{1}{100}, \frac{1}{600}$, gives an almost immediate precipitate.

4. $\frac{1}{300}, \frac{1}{600}$, gives very satisfactory results.

5. $\frac{1}{400}, \frac{1}{600}$, at this degree of dilution the precipitate is still perceptible, but not satisfactory.

When the precipitate obtained from a solution containing $\frac{1}{300}$ or less of its weight of strychnia is boiled, the precipitate will dissolve and give a yellow solution, from which it will again be deposited, with little or no change upon becoming cool. If the solution contains more than $\frac{1}{300}$ its weight, the precipitate will not entirely dissolve upon boiling, after cooling there will generally be a metallic gilding upon the sides of the tube. The precipitate from $\frac{1}{300}$ or more dilute solutions, will readily dissolve, without much change of color, upon the addition of a drop or two of potash solution; if then the mixture be boiled it will give a fine purple color, with sometimes a purple precipitate. When the precipitate is from a stronger solution than above stated, it does not readily dissolve in a solution of potash, and when the mixture is boiled it behaves as above.

10. *Chromate of Potash.*

1. $\frac{1}{100}$, gives an immediate mass of yellow crystals, soluble in 30 drops of strong acetic acid.

2. $\frac{1}{200}$, crystals begin to form in a few seconds, but they are not very abundant after standing 15 minutes.

3. $\frac{1}{300}$, with the microscope, a few prisms may be observed in 8 minutes, but no indication to the eye, after standing 20 minutes.

11. *Carbazotic Acid.*

This, and the three following tests have been formerly recommended in the lectures of the writer, the only account of them seen, is in the last edition of Taylor on Poisons, in which the iodine test is suggested.

An alcoholic solution of carbazotic acid will give with—

1. $\frac{1}{1\,0\,0}$, grain of strychnia, an immediate amorphous yellow precipitate soon becoming twig-like tufts.

2. $\frac{1}{1\,0\,0\,0}$, in a few seconds a precipitate soon becoming as in No. 1.

3. $\frac{1}{2\,0\,0\,0}$, by rubbing a few seconds, a copious deposit of granules.

4. $\frac{1}{1\,0}, \frac{1}{5\,0\,0}$, in about a minute the same as No. 3.

5. $\frac{1}{2\,0}, \frac{1}{5\,0\,0}$, in a few minutes small granules are very obvious.

12. *Bichromate of Potash.*

1. $\frac{1}{1\,0\,0}$, an immediate brilliant yellow mass of dendroidal crystals.

2. $\frac{1}{1\,0\,0\,0}$, in a few seconds same as No. 1.

3. $\frac{1}{2\,0\,0\,0}$, crystals begin to form in a few seconds, in a few minutes they are abundant.

4. $\frac{1}{1\,0}, \frac{1}{5\,0\,0}$, in a few minutes beautiful octahedra appear, resembling those of oxalate of lime. If the solution be rubbed the deposit becomes rather abundant.

5. $\frac{1}{1\,0}, \frac{1}{5\,0\,0}$, by rubbing, in a few minutes crystals are obvious with the microscope, in several minutes they are readily seen with the eye.

The precipitate produced by this reagent is not as readily soluble in acetic acid, as that produced by the protochromate of potash.

13. *Iodine.*

Of the various tests recommended for strychnia, this is the most delicate. It was applied in the following experiments, by dissolving three grains of iodid of potassium in one fluid drachm of water, and then adding to the mixture one grain of iodine.

1. $\frac{1}{1\,0\,0\,0}$, immediately a copious brownish yellow amorphous precipitate soluble in alcohol and ether, but only soluble in large excess of acetic acid. The precipitate partially dissolves in a few drops of potash solution, but it is immediately replaced by a dirty white precipitate.

2. $\frac{1}{2\,0\,0\,0}$, the precipitate entirely dissolves in potash, and is replaced by the white one.

3. $\frac{1}{3\,0}, \frac{1}{5\,0\,0}$, gives same results as No. 2, not so abundant.

4. $\frac{1}{2\,0}, \frac{1}{5\,0\,0}$, the precipitate dissolved in potash gives a very faint white precipitate.

5. $\frac{1}{2\,0}, \frac{1}{5\,0\,0}$, the precipitate is immediately produced and soon collects into little yellow flakes.

6. $\frac{1}{100}$, $\frac{1}{1000}$, if the drop be touched with a small drop of the reagent upon the end of a glass rod, it gives an obvious precipitate.

If a few drops of the last named solution be placed in a small test tube, and a drop of the test fluid be placed upon the inside and allowed to flow into the solution, when they meet, yellow streaks will readily be observed, and the solution will become turbid.

14. *Bromine.*

This reagent was prepared by saturating a strong solution of hydrobromic acid, with bromine.

1. $\frac{1}{100}$, gives an immediate bright yellow amorphous precipitate.

2. $\frac{1}{100}$, $\frac{1}{1000}$, a yellow precipitate, having a greenish tinge.

3. $\frac{1}{500}$, $\frac{1}{1000}$, a dirty yellow precipitate, which after several minutes nearly all dissolves.

4. $\frac{1}{1000}$, $\frac{1}{1000}$, the precipitate is still perceptible, but not satisfactory.

15. *Color Test.*

It is well known, that if strychnia or its salts be dissolved in sulphuric acid, and then a small quantity of bichromate of potash, ferridcyanid of potassium, peroxyd of lead, or of peroxyd of manganese be added, a series of colors are developed. This is known by the name of the "color test." This test succeeds best in the following manner: place the strychnia, or a drop of the solution evaporated to dryness, in a watch glass, and by its side a drop of strong sulphuric acid, into which a fragment of bichromate of potash is introduced and stirred until it imparts a yellow color, then by inclining the watch glass the colored acid is allowed to flow over the strychnia.

1. $\frac{1}{100}$ grain of strychnia in one drop of water, gave in a majority of a number of experiments, very satisfactory results, however, in some the reactions were just perceptible. In solutions stronger than the above the results were always good.

2. $\frac{1}{500}$, in many cases no indication whatever, in others a very faint trace of color was obtained, which however rapidly disappeared. In no instance was the indication such as should be relied upon for medico-legal purposes.

3. $\frac{1}{100}$ grain, dry, will always give a fine reaction. By allowing the acid to flow upon a portion of the deposit at a time, several indications may be obtained from the same deposit.

4. $\frac{1}{500}$, dry, in a majority of instances the indications were very good; in some, however, they were very faint. The success of the experiment depends much on the character of the deposit left by evaporating the solution to dryness; sometimes, the principal part of it is in the form of a ring, which when examined with the microscope consists of well defined crystals; at

others, it is a confused mass distributed over the space occupied by the drop. In the latter case the indications will not be nearly so good as in the former.

5. $\frac{1}{100}$, $\frac{1}{1000}$, dry, in a number of cases manipulated differently, the majority gave no indications, some few gave a slight trace, but in no instance was the indication sufficient.

As the color test is relied upon, perhaps, more than any other for medico-legal purposes, it is important to remember that it is interfered with by the presence of morphia. When one part by weight of strychnia is mixed with—

1. 1 part of morphia, it gives very good results. The colors, however, are not so bright as with strychnia alone.

2. 1½ of morphia, in a very small quantity of this mixture the indication of strychnia is very good, in a larger quantity, about $\frac{1}{500}$ gr., the reaction is just perceptible.

3. 2 of morphia, the indication in a very small quantity is pretty fair, but in about $\frac{1}{500}$ gr. there is only a mere trace.

4. 3 of morphia, in a very small quantity of this mixture, the reaction is just perceptible, but in a larger amount there is no reaction indicative of the presence of strychnia.

Columbus, Ohio, July 13, 1859.

ART. XXV.—*On the Consolidation of Lava on Steep Slopes, and on the Origin of the Conical Form of Volcanoes;* by Sir CHARLES LYELL, M.A., D.C.L., F.R.S.*

DURING two recent excursions made in the autumns of 1857 and 1858 to Mount Etna, Sir C. Lyell had an opportunity of examining sections of lava-currents of known date, which had descended steep slopes, and had consolidated thereon in tabular and stony masses, the inclination of which sometimes exceeded 30°. This fact has an important bearing on the theory of "craters of elevation," it having been affirmed by geologists of high authority, that when lavas congeal on a declivity exceeding 5° or 6°, they never form continuous beds of compact stone, but consist entirely of scoriaceous and fragmentary materials.

The origin of such mountains as Etna and Vesuvius had of old been referred to the cumulative effect of a long series of ordinary eruptions, it being seen that reiterated showers of ashes and streams of lava were often poured out from a permanent central vent. This opinion was advocated by Mr. Scrope in his work on volcanoes in 1825, and by Sir C. Lyell in his *Principles of Geology*, after his exploration of Vesuvius and Etna in 1828; both authors considering the injection from below of

* Proc. Roy. Inst. of Great Britain, April, 1859.

melted matter, in the shape of dykes, as part of the cone-making process.

But in place of this simple explanation of the phenomena, Von Buch substituted the following hypothesis: that a vast thickness of horizontal or nearly horizontal sheets of lava and scoriæ, having been first deposited, an expansive force operating from below, exerts a pressure both upwards and outwards, from a central axis towards all points of the compass, so as suddenly to uplift the whole stratified mass, making it assume a conical form; giving rise at the same time, in many cases, to a wide and deep circular opening at the top of the cone, an opening called a "crater of elevation."

In all great volcanoes of which sections can be obtained, there are some layers of compact stone, inclined at angles of 10°, 20°, and sometimes much higher angles, and these beds are often among the uppermost, or last formed of the whole series. Hence it was logically inferred, when once the law above laid down respecting the consolidation of melted matter had been accepted, that every mountain containing such inclined and compact layers, must owe its conical form almost exclusively to the development of mechanical force exerted at the close of the volcanic operations, or after all the alternating lavas and scoriæ were heaped up. The hypothesis of a sudden and violent movement was perhaps the more readily embraced, because it relieved its advocates from the necessity of making unlimited drafts on past time, thousands of centuries being required if lofty cones, like Mount Etna, are to be built up by successive eruptions of ordinary intensity. The magnitude also of certain craters or "calderas" (implying, probably, one or more great explosions, followed by aqueous erosion), and the occasional steepness of the dips of certain lavas, beyond that which is found on the flanks of ordinary cones, (many of which might have been assigned to local dislocation), afforded additional arguments in favor of the new hypothesis. The lecturer then gave a rapid review of the controversy respecting "craters of elevation," stating the objections made to it by English and continental writers, including the late M. Constant Prevost; and he went on to observe that the principal object of this discourse was to show that the law laid down by M. E. de Beaumont, and by the late M. Dufrenoy, as governing the cooling and solidification of lava currents, on steep slopes, has no foundation in fact. Signor Scacchi had already, in 1855, seen and described a compact stony lava which in that year had flowed down the flanks of Vesuvius from near the margin of the great crater to the base of the cone in the Atrio del Cavallo, having a thickness of from $1\frac{1}{2}$ in the upper to $4\frac{1}{2}$ in its lower part, and dipping at angles varying from 32° to 38°. The interior of this current was laid open to view by a rare accident,

namely, the sinking down in the same year (1855) of a certain portion of the north flank of the cone, whereby one side of the new lava stream was engulphed, and a section of the remainder rendered visible. Although this current had cooled on an average declivity of 35°, it was as compact and as free from vesicles as many lavas which have congealed on level ground at the foot of Vesuvius.*

The first exemplification of a similarly inclined stony lava of known date on Mount Etna, described by the lecturer, and of which a pictorial representation was given, occurs in a ravine called the Cava Grande, near Milo, about 17 miles north of Catania, and 7 from the sea, above the level of which it is elevated about 2000 feet. A branch of the lava current of 1689 descending from the Val del Bove, cascaded over the right bank of that ravine 220 feet high, and on cooling, formed a tabular mass more than 16 feet in thickness, inclined at an average angle of about 35°, and concealing the face of the precipice for a width of about 400 feet. The internal structure of this new lava has been exposed to view by the falling down and partial removal of its scoriaceous crust on the left side; a removal caused by the annual waste of the steep bank of the ravine produced by the action of rain, and the torrent which flows at the bottom. The ravine intersects alternating beds of tuff, scoria, and lava, slightly inclined to the east, or seawards, being a series of the older products of Etna. This new and steeply inclined lava consists of three parallel layers, an upper fragmentary and scoriaceous mass about 8 feet thick; a central stony layer, 5 feet thick; and a lower bed consisting of thin strata of fragmentary scoriæ, in all three feet thick, but the bottom part of which is not visible. The compact central portion is a dolerite or trachi-dolerite, containing crystals of feldspar with some olivine, and is of the ordinary specific gravity of trap. It is divided by joints, 9 or 10 feet apart, so that among the fragments detached by denudation, and strewed over the sloping bank and bottom of the ravine, are angular masses of huge size, with a fracture like that of many ancient igneous rocks. The normal thickness of this bed of compact dolerite is 5 feet, where it dips at 32° and 35°, but near the top where it first enters the ravine, and where the inclination increases to 45° and 47°, the thickness is reduced to one-half or $2\frac{1}{2}$ feet; yet when dipping at 47°, it is still not only stony and compact, but there is no breach whatever of continuity in the mass, and not more joints than in the less inclined portion. This branch of the lava of 1689, which has given a new facing to part of the right bank of the Cava Grande, exhibits but slight in-

* This section, seen by Signor Scacchi in 1855, was looked for by Sir C. Lyell, in company with Signor Scacchi in 1857, and found to be totally buried and concealed by the lavas poured out in the early part of that year.

equalities on its surface, appearing almost even when contrasted with the main current of the same date, from the surface of which many parallel and longitudinal ridges project prominently, sometimes 40 feet above their base, and with very steep sides sloping at angles of from 35° to 70°. The dip of the main current is between 10° and 16° east. From this and other examples, it is inferred that wherever the slopes are excessive (between 25° and 45°) the surfaces of the cooling lavas are less rugged than where the melted matter has congealed on more level ground.

Allusion was next made to some lavas which have cascaded over sea-cliffs 500 feet high, between Aci Reale and Santa Tecla. One of these at a place called the Scalazza of Aci Reale, exhibits a longitudinal section of a tabular mass of stony rock 20 feet thick, inclined at angles of 23° and 29°, which is connected uninterruptedly with the main body of the same lava resting on the gently sloping platform above, of which the sea-cliff is the abrupt termination. The above-mentioned highly inclined stony lava is covered as usual by a parallel layer of scoriæ (in this case 12 feet thick) and its base consists of another bed of scoriæ of slight thickness.

Several other sections of modern lavas of Etna, which have not been disturbed in their position since the day of their formation, and which are inclined at angles exceeding 30° were then enumerated. For a detailed account of those, reference was given to a paper by the lecturer, recently published in the *Philosophical Transactions* (Part 2 for 1858, p. 703). Among them is a current, inclined at 35°, occurring in the Cava Secca, a deep valley near Zafarana; and another reposing on the face of the great precipice at the head of the Val del Bove, under the sunk space called "The Cisterna." This remarkable current has a mean inclination of 35°, and the central stony layer is seven feet thick. Above and below are parallel overlying and underlying masses of scoriæ five and seven feet thick respectively. The flanks of the stream have been undermined and denuded by that constant waste which makes the innumerable dikes to stand out in relief on all the precipices surrounding the Val del Bove. Perhaps, also, in this instance, the lateral excavation of the lava may have been assisted by a rush of water like that of 1755, commonly called Recupero's flood, which descended the same precipice, the "Balzo di Trifoglietto." Suggestions were then offered on the probable cause of that singular inundation, which swept in a few hours from near the summit of Etna through the Val del Bove to the sea. The Canon Recupero traced its course, a few months after the event, by following the line of sand and boulders which it had left in its track; and calculated that the volume of water was so great, that, had all the snows of the top of

Etna been melted instantaneously, they could not have furnished enough water for the deluge. He, therefore, concluded that the water was vomited forth from the summit crater itself. Sir C. Lyell conjectures that there may have been masses of ice in the cone during the eruption which is recorded to have accompanied the flood of 1775, and the ice may have been suddenly melted by hot vapors and injected lava. In support of this hypothesis, he mentioned his having ascertained the continued existence, in 1858, of the same glacier which was alluded to by him in the first edition of his *Principles of Geology*, as occurring at the base of the cone, which had been quarried before 1828. This mass of ice the Catanians again quarried, four years ago, to a depth of four feet, without reaching the bottom. It is covered by ten feet of volcanic sand, and this again by lava. The tale of the mountaineers, who assured Recupero that the water of the flood of 1775 was hot, may have been correct, if the origin here assigned it be true.

Some account was next given of the lavas of 1852–53, which were still hot, and emitting columns of vapor at the time of Sir C. Lyell's last visit. They were more voluminous, perhaps, than any ever poured forth from Etna in historical times, except those of 1669, which overflowed a great part of the city of Catania. The narrative of the people of Zafarana, of the manner in which the frontal wall of lava, 30 feet high, and inclined at an angle of 37°, had crept slowly over green pastures and vineyards, and overwhelmed habitations in the suburbs of that town, reminded Sir Charles of similar tales which he had listened to seven weeks before in the Alpine valley of Zermatt, where the great glacier had, in the preceding spring, been pushing onwards with irresistable force, an equally steep mound of stony fragments, forming the frontal moraine by which green meadows, gardens, and chalets had been overwhelmed. A description was then given of the changes brought about by the lavas of 1852–53 in the scenery of the Val del Bove, and in that of the lower Valley of Calanna, in the interval since 1828, when the lecturer first visited Etna. These changes are very striking; the fresh currents having run from the head of the Val del Bove both in a northeast and in a southeast direction for a distance of six miles, with a breadth in each case of two miles, and having been piled up one over the other in some places (as at the Portella of Calanna) to a depth of more than 100 feet. The longitudinal and nearly parallel ridges on the surface of this new lava field are from 20 to 70 feet high; and there is now a black and monotonous wilderness in many places, where, in 1728, there were verdant forests.

One branch of this lava of 1852 cascaded over a precipitous declivity 500 feet high, at the head of the Valley of Calanna, and consolidated at angles of 35°, 45°, and even 49°. The scoriaceous crust having been partially washed off, the surface of a continuous crystalline and stony mass is exposed to view, only moderately vesicular, and having the steep inclinations above alluded to. This same current rests on an older one, that of 1819, which passed down the same steep cliff, and which has at some points a dip of more than 40°.

[The author continues with facts and reasonings similar to what is published in his paper of last year (this Journal, vol. xxvi, p. 214)]:

In conclusion, the lecturer gave a brief sketch of the series of geological events which he supposed to have occurred on the site of Etna since the time of the earliest eruptions, events which may have required thousands of centuries for their development. The first eruptions are believed to have been submarine, occurring probably in a bay of the sea, which was gradually converted into land by the outpouring of lava and scoria, as well as by a slow and simultaneous upheaval of the whole territory. The basalts, and other igneous products of the Cyclopean Islands were formed contemporaneously in the same sea, the molluscous fauna of which approached very near to that now inhabiting the Mediterranean; so much so, that about nineteen-twentieths of the fossil species of the sub-Etnean tertiary strata still live in the adjoining seas. Hence, as that part of Etna which is of subaerial origin is newer than such fossils, the age of the mountain is proved to be, geologically speaking, extremely modern. During the period when the volcano was slowly built up, a movement of upheaval was gradually converting tracts of the neighboring bed of the sea into land, and causing the oldest volcanic and associated sedimentary strata to rise, until they reached eventually a height 1200 feet (and perhaps more) above the sea level. At the same time the old coast line, together with the alluvial deposits of rivers, was upraised, and inland cliffs and terraces formed at successive heights. The remains of elephants, and other quadrupeds, some of extinct species, are found in these old and upraised alluviums. Fossil leaves of terrestrial plants also, such as the laurel, myrtle, and pistachio, of species indigenous to Sicily, have been detected in the oldest subaerial tuffs. At first the cone of Trifoglietto, and probably the lower part of the cone of Mongibello, was built up; still later the cone last-mentioned, becoming the sole centre of activity, overwhelmed the eastern cone, and finally underwent in itself various transformations, including the truncation of its summit, and the formation of the Val del Bove on its eastern flank. Lastly, the phase of lateral eruptions began, which still continues in full vigor.

ART. XXVI.—*Diluvial Striæ on Fragments in Situ;* by O. N. STODDARD, Prof. Nat. Science, Miami University.

WHILE examining a few days since the fossils and the striæ pertaining to the Silurian formation of this vicinity, I discovered gravel, small boulders, and fragments of the underlying rock, very much worn by diluvial agencies and manifestly now lying where they were when striated. They were nearly uncovered some three years since in forming a bed for a railroad; the remaining denudation has been accomplished by the action of the rains upon the unfinished and unprotected bed.

They have been exposed along the road for about fifteen feet, and across nearly the whole breadth. At one point the material was a mass of gravel closely packed, and covering several square feet; at other places fragments of Silurian limestone, mingled promiscuously with small boulders of granite, greenstone, hornblende and quartz, the whole embedded in compact clay. The striated surfaces were in the same plane, and at one point the underlying rock was exposed, also striated. The direction of the grooves varied from 5° to 8° south of east.

No one, I presume, will for a moment entertain the idea, that the one hundred and forty-one pieces composing this bed were transported to this spot, having been striated elsewhere, and accidentally deposited with their surfaces in the same plane, and their grooves substantially parallel. The chances against such an occurrence are so enormous, that we might with safety say, it could not happen except by miracle.

The bearing of this example upon the different theories of diluvial action is obvious. The agency of running water may be dismissed as utterly inadequate to explain the facts in question. Icebergs driven onward by the waves and currents of a palæozoic sea afford a solution but little more plausible. Icebergs might plough up the bottom and scatter the fragments, but could not retain them in place and striate them. It seems necessary to admit that they were firmly frozen into the clay and thus held in position, while some overlying mass slowly ground off their exposed surfaces. If we admit that the bed was frozen during the striating process, then must we also admit that it could not have been covered at that time by any considerable depth of water. It is hardly necessary to state to a geologist, that no known agency so admirably meets all the conditions of this case, and no supposition so satisfies the mind as this, that glaciers once overspread this region, holding the beds underneath frost-bound; and, while their enormous pressure downwards, prevented displacement in an upward direction, their motion towards the south, ground down, not only the rocks in

place, but also these fragments, almost as firmly fixed by frost as the rocks themselves. On examination, a few of the pieces were found to be grooved on the under surface also. In one or two cases the striæ on opposite sides were nearly parallel, but generally inclined at a considerable angle.

Probably these fragments were at first embedded in the glacier and received, while in that position, the scratches on their under surface, but were subsequently detached from the glacier, embedded and frozen in the clay, where they were reduced to the condition in which they were found.

It may not be amiss to remark in conclusion, that striæ are abundant upon the surface rocks of this region, their direction varying from 1° to 11° east of south. The most durable boulders generally exhibit upon one or more of their surfaces distinct traces of the same abrading agency.

Miami University, June 11th, 1859.

ART. XXVII.—*Vibrations in the Waterfall at Holyoke, Mass.;* by Prof. E. S. SNELL, Amherst College.

AT the meeting of the American Scientific Association held in Montreal, August, 1857, I read a paper on the vibrations of the fall at Holyoke, in which I attributed the movement to the rarefaction of air in the tube behind the sheet, this rarefaction being caused by the action of the water, which carries down the adjacent air, and throws it up in foam mostly on the outside of the fall. In that paper I described two modes of vibration which I had observed, that agreed well with the supposition of acoustic pulsations in a tube of air 1008 feet long, and having *two* nodal sections in one case, and *four* in the other. I also stated my impression that I had, many years before, noticed a much slower rate of vibration, which accorded equally well with the existence of *one* nodal section in the tube.

Since the reading of the above-mentioned paper, I have observed the condition of the fall at four different times. In October and November, 1857, I noticed the same rates of vibration very nearly, which I had previously reported. But on the 16th of April, 1859, I found the water four or five feet deep on the edge of the dam, the temperature of the air about 45°, and the number of oscillations only *eighty-two* per minute. Again, on the 25th of July last, I found the water lower than I had seen it before, (less than three inches deep,) and no vibrations, either in the sheet, or the air at the end of the cavity behind it.

There are, therefore, at least *three* very different rates of vibration in this fall, the slowest when the depth of water is greatest,

and the most rapid when it is about one foot deep, the vibrations ceasing altogether when the depth is so small as three inches. In the following tabular statement, the four first columns show at once the facts as they stand connected in the few observations which I have made, and the last column contains the numbers calculated for an open tube 1008 feet long, with *four* nodes for the *third* and *fourth* observations, *two* nodes for the *first*, *second*, and *fifth*, and *one* node for the *sixth*.

	Time of observation.	Temperature of air.	Depth on Dam.	Observ'd No. vibrations per min.	Calculated No. vibr. per. min.
1	July 25, 1857,	80°	2 feet	137	136
2	July 29, "	75	2 "	136	136
3	Aug. 6, "	75	1 "	257	271
4	Oct. 7, "	65	1 "	258	268
5	Nov. 24, "	30	2 "	140	129
6	Apr. 16, 1859,	45	5 "	82	66
7	July 25, 1859,	70	3 inches	none	none

I used the formula in Peirce's Treatise on Sound, $N = n\frac{V}{L}$, where N is the number of vibrations, n the number of nodes, V the velocity of sound, and L the length of the tube. It is observable, that the calculated rates are higher than the observed, in the cases of most rapid vibration, and lower, in those of least rapidity, while in the medium rates, they very closely agree. As to the seventh case, the sheet was so thin, that it was divided into filaments and broken into spray, and the air had free ingress and egress through its whole length; the acoustic tube being thus destroyed, no vibrations could be produced.

Notwithstanding the discrepancies between the numbers in the two last columns, I think the general correspondence between them points to the true nature of the cause, especially when taken in connection with the fact, that the pulsations are noticeable only in the water and in the air,—not at all in the dam itself, nor in the rock or soil immediately adjacent. It must be remembered also, that the pitch of musical pipes does not fully conform to the formulæ, but varies with the breadth of opening and the mode of exciting vibrations.

This seems to be one of the numerous cases, in which the body which excites vibrations in another, is itself thrown into synchronous vibration by reaction, and then, by its own inertia or elasticity, controls the common rate of both. The sheet of water in its descent first produces rarefaction of the enclosed air by removing a part of it. The immediate effect is a collapse of the sheet of water, as well as a rush of air in at the ends. But the inertia of a thick mass of water will prevent its recovering its natural position so soon as if it were thinner; hence, the air-column divides itself into such a number of segments, that the water and the air can adjust their movements to each other.

In a manner somewhat like this, a stream of air from the lips, driven across the embouchure of a flute, excites vibrations in the column of air, with such frequency that it can itself vibrate in unison with it. But, if the stream is blown more and more swiftly, its elasticity will at length be too great for so slow a rate, and then the column will divide into shorter segments, and the two will continue their vibrations harmoniously upon a higher key. A skillful player can in this way by his mere breath produce *six* or *eight* harmonic notes on the flute, when all the holes are closed.

At the time when I witnessed the comparatively slow oscillation of 82 per minute, I was surprised by the great strength of the current of air, as it rushed into the opening at the end of the dam. I could not venture within the passage through the pier, lest I should be swept in behind the sheet; nor could I stand at the entrance of the arch, without bracing myself, by placing both hands on the corners. There was, however, no alternate *outward* blast, but only a lull, or cessation of all motion; which shows, that the excess of air that pours in at every pulse, is carried out again in some other way; and there is no conceivable way for it to escape, except to be driven down by the falling water, and poured up externally in a bed of foam. It had never occurred to me before, that the velocity of the air-current must be greater, the longer the interval between the pulses, since the rarefaction within the tube will be greater nearly in the ratio of the same interval.

In September, 1857, a paper was read before the Boston Society of Natural History, in which objections were made to my view of the source of the vibrations, and the cause assigned for them was the impulse on the rock produced by successive swells of the sheet, extending parallel to the edge of the dam, from one side of the river to the other. If this is the cause, then the vibrations are first excited in the rock, and communicated thence to the air. But the *rock* and *soil* in the immediate vicinity of the Holyoke fall are not perceived to move in the least, while the *air* sways a loose garment back and forth three or four inches, keeping time with the visible and audible pulsations of the sheet of water, and at the end of the tube sometimes rushes so violently, that a man can scarcely stand against it. That alternate swells and contractions cannot exist in a falling sheet of water, and if so, that they cannot cause sensible undulations in the earth, I am not prepared to assert; but I believe that any unbiased observer will find it quite absurd to apply such an explanation to the strong puffing of the air which is usually so noticeable at the Holyoke fall.

Art. XXVIII.—*Caricography;* by Prof. C. Dewey.

(Continued from vol. xxiv, p. 48, Second Series.)

No. 254. *C. alata*, Tor. Mon.

Spica composita; spiculis 5–8, ovalibus, sessilibus, crassis, superne aggregatis, densifloris, infirne staminiferis; fructibus suborbiculatis, interdum obovatis, distigmaticis, subplanis, abrupti brevi-rostratis, bidentatis, lato-alatis, rostro subscabris, squama ovato-lanceolata brevioribus.

Culm 3–4 feet high, smooth, with rough edged leaves; pale green; stigmas two. North Carolina and Georgia—*Torrey;* Florida—*Chapman;* a pine sedge-grass.

255. *C. striata*, Mx. Boott, Illust., No. 141.

Spicis staminiferis, 1–4, sæpe 2, oblongis, cylindraceis, erectis, subrubris, inferioribus sessilibus et brevioribus; pistilliferis 2, raro 1, oblongo-cylindraceis, erectis, bracteatis, densi-floris, suprema sæpe apice staminifera, tristigmaticis; fructibus ovatis acuminatis sub-inflatis brevi-rostratis scabro-pubescentibus nervosis ore bifidis, squama ovata acuta fusca vel sub-rubra albi-marginata duplo longioribus.

Culm 1–2 feet high, erect, stiff, leafy-bracteate, longer than the striate and lanceolate leaves, reddish at the root.

Penn.—*Muhlenberg;* New Jersey—*Torrey* and also *Knierskern;* Florida—*Chapman.*

Confounded with *C. polymorpha*, Muh.; but Dr. Boott found the Florida plant, fully like the others, to be *C. striata* in the Herbarium of Micheaux. This discovery makes a change in its designation: it led also to the other changes. Thus,

C. Halseyana, vol. xi, p. 313, of this Journal, becomes var. 2 of *C. polymorpha*, Muh. Gram. p. 239. Boott, Illust., No. 56. If this change should prove untenable, the original name can be restored. Years after *C. Halseyana* was named, I found it with different forms, named polymorpha in Muhl. herbarium.

256. *C. utriculata.* Boott. Illust., No. 37.

Spicis staminiferis 3–4, cylindraceis, erectis, gracilibus; pistilliferis 2–4, sæpe 3, longo-cylindraceis magnis subremotis, sæpe apice staminiferis, sessillibus, longo-foliaceo-bracteatis, infirma inferne attenuata et *laxiflora* et sub-pedunculata fructibus tristigmaticis ovati-oblongis vel ovata ellipsoides, cum rostro terati et bifurcato, glabris, subinflatis, stramineis, revorsis, squama lanceolata purpurea, angusta scabro-aristata longioribus.

Culm 2–3 feet high, erect, strong, shorter than the broad stiff rough nodose and reticulate-veined leaves; plant glaucous-green, except the yellowish spikes.

Abundant over the country by streams.

Confounded in our country with *C. ampullacea*, but separated some years since by Dr. Boott in Hook. Flor. Bor. Am.

C. ampullacea var. *utriculata*. Carey in Manual, and this *var.* much the most common.

Var. sparsiflora, Dew. All the spikes long, 3–6 inches, slender, and the pistillate quite loose—flowered and more lax below and attenuated; fruit smaller, and scale longer.

Note.—The following changes in the names of some species, already described in this Journal, become necessary, and some corrections.

C. gynocratis, Wormsk. is due to that difficult form, *C. davalliana*, Wahl., vol. x, p. 283 of this Journal, and the characters need to be more full.

C. gyrocratis, Wormsk. Kunze Supp., t. 31.

Spica unica, dioica; pistillifera oblonga sublaxiflora; fructibus sub-ovalibus vel oblongis basin teretibus, nervosis, cum rostro convexo-tereti sub-brevi recto vel sub-recurvo bidentato, maturis sub-horizontalibus, squama ovata acuta paullo longioribus.

Culm 4–6 inches high, roundish, glabrous, sulcate, longer than the strong, linear, sub-recurved leaves.

Wayne Co., N. Y.—*Dr. Sartwell*, as well as Greenland and Alpine Lapland.

C. tenella, Ehrhart, not Schk., is the oldest name of *C. Persoonii*, Sieb., in this Journal, vol. xix, p. 253, Second Series. For synonyms, see also Carey in Manual, 514. This name of Ehrh. is the true designation.

C. lenticularis, Mx. Boott, Illust. No. 76.

Since the description of this species in this Journal, vol. v., p. 175, Second Series, it has been found on the White Mts., N. H., also at Lake Avalanche, N. Y.—*Torrey* and *Gray*. Staminate spike 1, rarely 2; pistillate spikes 2–5, cylindric, obtuse, and distigmatic; fruit oval or ovate, short-rostrate.

ART. XXIX.—*Description of Nine new species of Crinoidea from the Subcarboniferous Rocks of Indiana and Kentucky;* by SIDNEY LYON and S. A. CASSEDAY.

IT was our intention originally, to publish the description of these, and other western Crinoidea, in the fourth volume of the Report on the Geology of Kentucky; but as many of our new and most interesting fossils find their way to the cabinets of European palæontologists and are described by them in continental journals, we determined to lay before the public the results of our labors at the earliest possible moment. We have drawings of all the species described, which we will publish sometime during the winter of the present year.

GONIASTEROIDOCRINUS, n. g., Lyon and Casseday.

Generic Formula.

Basal pieces, 1×5, pentagonal perforation not visible.
Subradial pieces, 5, hexagonal, nearly equal in size.
Primary radials, 3×5, first radial spinigerous.
Secondary radials, 3×10, hexagonal.
Interradial fields, 5×13, to 14.
Interbrachial fields, 5×7, to 9.

Arms, 5, nearly round, composed of about seven rows of small hexagonal pieces resting midway between the primary radials and supported by a right and left branch of the alternate ray on each side of them severally. Non ciliate. The interbrachial fields support long, pendulous cilia, from five to seven in each field.

Summit, pentagonal, composed of numerous polygonal pieces, some of which form raised folds enclosing fields of smaller pieces. Mouth depressed, sub-central.

Column, round, stout, composed of thin pieces alternately larger and smaller, the larger are the thickest.

The generic name was suggested to us by the resemblance of the summit to a Goniaster.

Goniasteroidocrinus tuberosus, n. sp.

Body, general form subcylindrical, or like a rounded pentagon, a little higher than wide, base deeply excavate. Summit plane or slightly elevated near the centre; the first radials are prolonged downwards and outwards into a spinous process.

Basal pieces five, forming together a regular pentagon; nearly covered by the supra columnar piece.

Subradials five, large, hexagonal, nearly equal in size, joined together, the margin presents four angular, and five plain margins between the

angular notches. The basal, subradial and part of the first radial pieces are seated in the basal pit.

Radials. The first, five in number, are septagonal and spinigerous. The second, five in number, are hexagonal and a little smaller than the first radials. The third radials also five, are septagonal and axillary, their upper oblique margins each supporting three brachials which are hexagonal and reach to the free arms; the brachials are a little smaller than the radials.

Interradial fields. These are five in number, almost identical in size, form, number and arrangement of the hexagonal pieces which compose them. The first rests upon the square end of the subradials, supporting on its upper margin a row of four or five hexagonal pieces gradually diminishing in size from below upwards. The outer oblique margins of the first interradial support each a row of four or five pieces similar to the middle row, these fit into the angular spaces between the middle row of the interradial field and the radials on either side, and reach the arm at the summit of each interradial field.

All the pieces of the calyx rise into a pointed knob near their centres, from which runs a raised fold or rib to the centre of all the surrounding ones. The knobs and ridges of the radials and brachials are more prominent than those of the other pieces: on old specimens the ribs become obliterated and the centre of the pieces more prominent. The basal and subradial pieces have plane surfaces.

Interbrachial fields. These spaces are covered by from seven to nine small pieces, forming together a scutiform console or supporting piece. They stand prominently above the general surface of the body; the lowest is the largest, the others are similar to those forming the arms.

Arms. The arms are five in number, composed of seven or eight rows of small hexagonal pieces. At a short distance from the body the arms branch and terminate in a point, the pieces becoming gradually smaller from the body outward, and the number of rows diminishing. The arms bear no cilia and are always found pendulous. Midway between the arms and attached to the superior margin of the interbrachial fields and depending therefrom, are from five to eight long delicate plumose cilia; they are composed of two or more rows of hexagonal pieces the same size throughout their whole length; they bear delicate pinnules which curve upwards.

Summit, flat or slightly elevated, nearly a regular pentagon, covered by a great number of polygonal pieces which are elevated into rounded knobs. About the centre is a cluster of pieces, (a central piece surrounded by five, six, or seven others,) very much larger than the remainder from which proceed strong, curved ridges meeting at the arms, and enclosing five sunken fields which vary in size and in the number of the pieces forming them. Without and along the margin are five fields, irregular in size and form, consisting of from six to fifteen pieces. The mouth is situated near the centre in the largest field on the summit, and can always be distinguished by the greater number and smallness of the pieces surrounding it, it is round and depressed.

Dimensions.

Diameter on second radials,	1·00 inch.
Height from base to arms,	·20 "
Length of spines on first radials,	·20 "
Greatest diameter of summit,	1·20 "
Least diameter of summit,	·80 "
Greatest height of summit,	1·00 "
Length of arms of a specimen whose summit diameter is $1\frac{29}{100}$ inch length to bifurcation,	·70 "
Length of longest branch,	1·10 "
Length of ciliated branch,	1·60 "
Thickness of ciliated branch,	·5 "

Geological position and locality. Found in the beds near the top of the knobstone member of the subcarboniferous beds on Clear Creek, Hardin Co., Ky., also in the same geological position in Washington and Montgomery Counties, Indiana. Its vertical range is quite limited. A crinoid (*Acanthocrinus longispina*) closely resembling ours has been found near Coblenz, and at several other Rhenish localities. It was first described by F. A. Roemer in 1850,* and again in 1854 by Zeiler and Wirtgen,† the differences are such that we unhesitatingly refer our fossil to a new genus. The columns are very unlike. Although closely resembling each other in the interradial and anal fields, and the number of radials, yet they differ widely in the arrangement of the brachials as they approach the arms, the interbrachial fields and the summit. Instead of from sixty to eighty arms all similar, our genus has only five larger arms and several smaller fimbriated appendices (arms?) Besides one is from Devonian rocks whilst the other is only found in Sub-Carboniferous strata.

Forbesiocrinus, De Koninck and Le Hon.

Forbesiocrinus multibrachiatus, sp. nob.

Body subglobose where the arms are folded inward as is usually the case; from the base to the free arms somewhat discoid, robust, externally covered with minute granules.

Basal pieces, three, similar in form and size, forming by their outer margins apparently the upper joint of the column, slightly thickened opposite the middle of the pieces.

Subradial pieces, five, in good specimens presenting five obtusely angular pieces disconnected from each other, resting apparently upon the supra columnar piece.

Radial pieces, 1*st series*. Generally four in each ray, the first five (resting between the angular points of the subradials), are irregular in size and form, four are irregularly hexagonal, twice as wide as high, the fifth pentagonal and much smaller than either of the others. The second and third radials are obscurely hexagonal, similar in form, differing

* F. A. Roemer, N. Jahrbuch für Min., etc., 1850. p. 679. taf. vi, B.

† Zieler and Wirtgen Verhand. Nat. Hist. Verein der Preus. Rhinelande, &c. Bonn., 1855.

lightly in size: the fourth is axillary, obscurely six-sided, rising into a long angular point; on each of its oblique upper sides supporting three pieces of the secondary radials, which are similar in form and nearly as large as the first radials. The last of these being axillary support on their upper oblique margins each, from four to seven brachial pieces: these last are again axillary, and bear on one side a branch of from twenty-five to thirty pieces, on the other branch which is again divided on the sixth or seventh piece above the first division of the arms, each branch of this last division being composed of about twenty pieces.

Interradial fields, 1st series. These fields consist of about fifteen pieces each, the first of which rests upon the upper oblique margin of the first radial of the first series. Usually hexagonal, small, this supports two of the second row, similar in form and size; these last again support three of the third row, of the same form but a little larger; these again a fourth row differing slightly in form and size, which are followed by two superior rows of ten pieces each, of irregular forms, sometimes there is another at the summit of which completes the field.

Interradial fields of the 2nd series, five, composed of pieces similar in form, from six to seven in number, variously arranged, sometimes one surmounted by two similar pieces, these by two others, then a smaller one, or one at the base, with one above the other, these again by two ranges of two, then one, all these forms are occasionally found in the same specimen.

Interradial fields of the 3rd series. Usually ten, composed of from three to five pieces, not regular in form or arrangement, occasionally some of the fields are obscure or absent.

Anal pieces, six. The first is septagonal and rests upon the large subradial; upon it are two pieces, nearly similar in size; in the angle formed by their junction is one irregular shaped piece supporting two quite small quadrangular ones.

The arms are twenty in number, of irregular length, each branch divided into three fingers, making sixty in all: they are free from the third or fourth piece of the third division.

The arrangement of the several series of interradial fields between the branches of the arms produces a very large cup, in proportion to which the rays are quite short. The general form of our species is somewhat like that of *Ichthyocrinus lævis*, (Conrad) Hall's figure, New York Geol. Rep., pl. 48, fig. 2. In the arrangement of the rays and the interradial fields in three series, it approaches *Forbesiocrinus Wortheni*, Hall (Iowa, pl. 17, fig. 5), from which it differs widely in the number of anal pieces.

Our specimens are nearly perfect, none of them exhibit the patelloid pieces of *F. Wortheni*, Hall. In several species of this genus which have come under our observation there are no patelloid pieces, in a few of our specimens (the prolongation of the superior pieces near the centre of their breadth overlapping the inferior) some of the prolongations are fractured, specimens of this character have probably led to the remark of Mr. Hall before cited. It is highly probable that this prolongation in the living animal was less calcareous than the remainder of the piece, and owing to this circumstance, was differently mineralized from the mass of the piece. This very difference in the composition of the pieces, supposing that the

prolongation was cartilaginous and the rest of the piece bony, would give flexibility to the body of the calyx and would have been especially useful to our similarly arranged species, whose rays are soldered together by the intercalation of three stories of intermedial and interbrachial fields.

Our figures are drawn the size of nature from the largest perfect specimen that has come under our notice, fragments have been found of larger individuals.

Geological position and locality. Rare in the beds of the subcarboniferous limestone near the top of the knob sandstone, Clear Creek, Hardin county, Ky. Also in the same beds in Washington and Montgomery counties, Ia. Vertical range unknown, it is probable that it is quite limited.

Forbesiocrinus ramulosus, sp. nobis.

Body discoid, rays long, prominent.

Basal pieces, three, of equal size, not projecting beyond the column, in perfect specimens appearing like the upper joint of the column; having an unequal thickness, the thickest part being in the centre of the width of the pieces.

Subradials, five, pentagonal, low, four times as broad as high. *Radial pieces*, the first are about twice as wide as high, obscurely quadrangular or pentagonal, lower margin convex, upper concave in the center, convex on the outer corners; the second and third are similar in size and form; the fourth are pentagonal, similar on their lower margins to the first, second and third, increasing in breadth at the centre where they terminate in an elevated point. The first and second radials join each other, the remainder do not touch at any point.

Secondary radials. The oblique upper margins of the fourth primary radials support each, two branches, varying from four tc six pieces (usually four), to the second bifurcation. In like manner the main divisions of the rays, ten in number, branch to the right and left alternately to the end of the main branches, making generally from 14 to 16 branches. These larger branches are subdivided from three to five times.

Anal pieces, usually from four to six. The first is the largest piece in the circle of subradial pieces, hexagonal; on its upper margin is placed a rectangular parallelogramic piece three times as high as wide, on this rests three or four small pieces one above the other.

Interradial pieces. Between each primary ray there is one, sometimes two, hexagonal pieces. It is not uncommon to find some of the rays without an interradial, in the young they are seldom present.

Interbrachials. Usually one between the main ray and the first divisions, sometimes these pieces are found between the main branches and the second, third and fourth divisions. In well preserved specimens the whole body and arms are covered with minute granules.

Column, round, diminishing from the body downwards, composed of very thin circular pieces, with a still thinner muscular (?) piece, separating them; a good lens is required to see this dividing member between the articulations of the column.

Dimensions of medium sized Adult:

Breadth of basal pieces, - - - - - -	·45 inch.
Height of subradials, - - - - - - -	·20 "
Width of " - - - - - - -	·45 "
Length of first 4 radials, - - - - -	·75 "
Length of arms, - - - - - - -	3·75 "

This crinoid is referred with some doubt to *Forbesiocrinus* of de Koninck as defined by Jas. Hall, Geol. of Iowa, part 2, p. 630. In technical strictness this is not *Forbesiocrinus*, and will not fall into that genus. This particular section of the crinoidea appears to have been a stumbling block to all palæontologists up to this time. The variety of opinions advanced, and the number of genera erected, to receive analogous forms has not diminished the difficulties pertaining to the subject.

Our species has from four to six anal pieces *and no more*, the generic definition requires ten to twenty-four or more; in our specimen the arms are ten, branching, having no tentaculæ, the generic definition requires forty to sixty. If the branches from the first bifurcation are taken as arms, ours instead of ten as we define it to have, has $10 \times 16 = 160$ arms. These differences should certainly be generic, yet the analogy of form is such that it is proposed to modify and extend the generic formula and admit this and other allied forms.

Geological position and locality. Subcarboniferous limestone, Hardin Co., Ky., and in similar rocks in Indiana.

Actinocrinus. (Miller.)

Actinocrinus cornigerus, sp. nobis.

Body. General form subglobular, conical, below the arms having the form of an inverted cone which is about two-thirds the length of the entire body, the whole surface beautifully ornamented with carina, spines and tubercles.

Basal pieces, three, prominent, nearly equal in size, forming together a large irregular hexagon: each piece has a broad leaf-like expansion raised upon its outer margin, overlapping and partially concealing the sutures formed by their junction with the row of pieces following them. Opening pentaphyllous.

First radials, five, hexagonal, near the centre of each is a prominent tubercle from whence radiate six fasciculi of from two to six ribs each; these extend to the edges of the pieces where they are met by similar ones from the next piece, thus forming a series of triangular markings, the points of the triangles resting near the centre of each three adjacent pieces. The lateral markings surrounding the base are quite prominent and form around it a raised hexagon.

Second radials, five, hexagonal, a little smaller than the first radials and similarly ornamented.

Third radials, five, two of which are hexagonal, the others being pentagonal. The strong rib which proceeding from the centre of the first, and extending over the second radials, bifurcates near the centre of the third, giving off two ribs. From the upper margin of the third

radials rise two radials of the second series: on each of these the rib again bifurcates. Each of these last pieces bear two others; on those nearest each other the rib again bifurcates, each branch of the first bifurcation thus bearing three ribs, which are here joined to the free arms.

Interradial pieces. Generally from three to seven, they are disposed as follows: first, a large hexagonal one succeeded by two nearly equal to it in size, also hexagonal, then follow sometimes two, three or four, differing in form, these again are followed by a number of small hexagonal pieces.

Anal pieces, seven to sixteen; the first of the series is hexagonal, in the same circle with the first radials, equal to them in size and having the same ornament, this piece is followed by two others as in the interradial fields, except that the pieces are generally smaller. Upon these succeed four, sometimes more, which are followed by three regular and a cluster of four petal-like pieces with one to the right of the cluster completing the row. The ornature of all these pieces is the same as on those already mentioned, being quite as prominent on the small as on the large pieces, thereby causing an extraordinary rugosity on the smaller pieces.

Interbrachial pieces. In a line with each ray, interposed between the brachials, are two interbrachials, one immediately above the other.

Vault. The surface of the vault is thickly studded with granular markings except on the anal side. The summit frequently has a long spine, nearly central, from which proceed raised folds projecting toward the arms, terminating at a spine or circularly disposed group of pieces around a central one. A short distance within the circle of the arms, along the centre of the folds, the pieces are generally larger than on the interval between them, the tubercles are also much more prominent on these larger pieces. On the anal side the vault is more convex than on either of the other sides, it is covered by about twenty-five or thirty small polygonal pieces not ornamented like the other pieces composing the vault: near the centre of them is a cluster of nearly smooth pieces, six of them very minute and angular, surrounded by six larger angular pieces, making together a stellate figure of six points both falling into and nearly covering one of the hexagonal spaces composing this part of the vault.

Column, round, near the body composed of pieces alternately larger and smaller. Our species resembles most closely *A. costus*, (McCoy) both in its general form, size, disposition and ornature. The absence of a central proboscis, the difference of the basals, the garniture of the vault and the greater number of the arms, renders it an easy task to distinguish between them.

Geological position and locality. Found in great abundance at the quarries on Beargrass Creek, near Louisville, also at Rock Island, Falls of the Ohio. Very few perfect specimens have been obtained. The vertical range appears to be quite small having been procured only from a thin bed of limestone, seven feet thick, situated between the black slate and hydraulic limestone beds near the top of the Devonian rocks in the neighborhood of Louisville, Ky.

Actinocrinus, sp. nobis.

Body, uniform, symmetrical, enlarging rapidly beneath the arms, vault tumidly conical, centrally surmounted by a strong proboscis nearly as long as the height of the body. Base plain below, slightly excavated for the reception of a large column which is round, composed of alternately thick and thin pieces.

Basal pieces, hexagonal, thick, low, margin and angles rounded, slightly inflated, projecting beyond the column around which it forms a pitaliform border, perforation small, pentagonal.

First radials, hexagonal, much smaller than the basal pieces, on the upper margin of which they rest, prominently marked, transversly, by a long knob a little below the centre of the pieces.

Second radials, very small, subquadrangular, nearly as high as wide, inflated in the same manner as the first radials.

Third radials, much larger than the second, differing in size and form, obscure octagonal, septagonal and hexagonal, some higher than wide, others four times as wide as high: on their oblique upper margins they support a series of two secondary radials each, the second of which are axillary, supporting usually four brachials, three being subquadrangular, about four times as wide as high, the fourth obscurely pentagonal, bearing two long delicate arms composed of a double row of joints; the arms become free from the last brachial. The two postero-lateral rays have an additional arm on those branches joining the anal pieces. This gives each postero-lateral ray five arms, and four to each of the others, making in all twenty-two arms of two fingers each. These fingers are fringed with fine long cilia.

Interradial pieces. The first is large, (inferior in size to the first radials), hexagonal, ascending sides diverging, and resting in a deep angular notch between the first radials and similarly inflated; the oblique upper margins support each a piece of the second row, which differ much in their size and form, one in each field usually hexagonal, the other pentagonal, joined they present an angular notch between their summits in which rests one piece; sometimes another, quite small, is added.

Anal pieces. The first is septagonal, and is the largest piece, composing the circle about the basis; upon this rests three pentagonal, or obscurely hexagonal, pieces of the second range; by the same arrangement are added the third and fourth range, each range being composed of smaller pieces than the preceding one, sometimes a small lanceolate piece surmounts this pyramid completing it to the level of the arms. The first anal piece is marked like the first radials, the others are ornamented by a low, central tubercle.

Vault. The vault is covered by numerous polygonal pieces differing slightly in size, inflated, terminating in a point more or less sharp and round near the center of the pieces.

Proboscis. This like the vault is covered by polygonal pieces which differ remarkably in size, knobbed or spinigerous, the side corresponding to the anal side being covered by oblong pentagonal pieces some of which bear a range of two or three knobs or spines, on the opposite side the pieces are relatively much smaller, and the spines longer.

Dimensions of large Specimen.

Height of calyx,	·95 inch.
" " vault,	·70 "
" " base,	·20 "
Length of proboscis (not complete),	1·80 "
Height of calyx, vault and proboscis,	3·20 "
Length of arms partly concealed,	3·45 "

Geological position and locality. Imperfect, but recognizable, specimens occur at the quarries near Louisville and Nashville Railroad, Clear Creek, Hardin Co., Ky., associated with *Eretmocrinus magnificus*, &c. For the specimen figured we are indebted to the cabinet of O. A. Corey, Esq., who with praiseworthy liberality, placed at our disposal the whole of his splendid cabinet of crinoidea. *A. grandis* is nearly related to *A. turbinatus*, Hall (Iowa, p. 587, pl. ii, fig. 1), also to *A. longirostis* (Ib., pp. 589, 590), from both of these our species differs in the ornature of the pieces, the number of arms, and so far as may be determined, by the figure and descriptions referred to, by the pieces covering the proboscis and the vault, and the number of pieces composing the anal and interradial fields.

Actinocrinus, Miller.

Sub-Genus, Eretmocrinus, Lyon and Casseday.

It is proposed to erect a sub-genus, *Eretmocrinus*, to receive a class of crinoids having the general arrangement of parts by which actinocrinus is recognized, yet differing so widely from that genus in the structure of the arms, the base, and the general appearance as to be instantly recognized. The structure of the arms differing so remarkably from all known genera, would at once suggest a difference of habit in the animal.

Generic Formula.

Basal pieces,	3, large and extending beyond the calyx.
Radial "	3×5, very small.
Brachial "	3×26.
Interradial "	2×4, one larger and one smaller.
Anal "	6×8.
Interaxillaries,	0.
Proboscidiferous.	

Arms, 26, long paddle shaped, deeply grooved on the inner face, fimbriated on both sides of the groove.

The generic name was suggested by the oar-like arms of this splendid crinoid.

Eretmocrinus magnificus, sp. nobis.

The general form of the body is that of a double cone, the point of the inferior cone truncated and one third shorter than the upper one, which is prolonged by a proboscis or oval tube; the whole body rugose and below the arms covered by minute granular markings.

Basal pieces three, large, nearly equal in size, forming together a basis resembling a thick button, the margins projecting a considerable distance beyond the body where it joins to it, deeply concave below, the depression left by the column forming a still deeper concavity, occupying about half the diameter of the whole base, the centre being perforated by a small pentapetalous opening.

First radials five, very minute, quadrangular, thrice as wide as high.

Second radials similar in form and size to the first radials. The third radials are axillary, twice the size of the first, and support on each bevilled edge two pentagonal secondary radials, the last of which are again axillary, giving off two rows of three pieces each to the free arms, except in the postero-lateral rays, where the third secondary radial becomes again axillary and supports on each bevilled edge two rows of three pieces which reach to the free arms; the postero-lateral rays supporting five arms each, the others only four. The brachials are considerably broader than long, and so arranged that the salient angle of one piece fits into the retreating angle formed by the two pieces opposite it. Commencing at the junction of the base with the first radials rises a row of single carinated protuberances, more or less prominent, extending from the base along the middle of the rays and their branches to the free arms distinctly marking the course of the rays.

Interrodials usually two, a large hexagonal one followed by a smaller one of similar form.

Anal pieces six, the inferior three are pentagonal, their inferior and lateral margins nearly equal, the lines defining the upper are shorter and produce a sharp angular point at the summit of the pieces: between these angular points of the first range, rest two hexagonal pieces a little inferior in size to the first; upon these last rests a hexagonal piece still less than those of the second range. The surface of the anal and interradial pieces are plain surfaces, except the fine granular markings before described.

Vault. The vault is of an elevated conical form surmounted by a proboscis, the whole being covered by irregular sized pieces, generally hexagonal in form, rising from the margins toward the centre and terminating in a point—in some specimens, the centre of the pieces are marked by two or sometimes three points. It happens that all these forms are found in the same specimen.

Arms. The arms of this splendid crinoid are so unlike anything before described as to merit special attention. They are (on medium sized specimens), about four inches in length. They rise from the calyx in a sub-rotund column about one third of their length, when they flatten and expand towards the top: at the middle of their length they are half an inch wide and about a sixteenth of an inch thick, for a short distance the margins are parallel when they suddenly contract by a graceful curve to about half their greatest width, the sides again becoming parallel for half an inch, when they close by a circular curve which bounds the upper extremity. The insides of the lower parts of these arms are flattened and grooved by a deep semicircular sulculus, the margins of which are lined with very fine, long cilia up to the enlargement of the arms, beyond which they cannot be traced, in fact we suppose

they extend only so far. The body of the arm is composed of a double row of pieces, very small below, increasing in size upward; where the arms are most expanded they number about twenty-four to the inch, in the lowest part from thirty-six to thirty-eight to the inch.

Geological position and locality. Found in vast numbers in the quarries near the Louisville and Nashville Rail Road, Clear Creek, Hardin Co. Kentucky, at numerous localities in Indiana, in beds near the top of the Knob member of the sub-carboniferous rocks. On Clear Creek the horizon of our species is 180 feet below the equivalent of the *Batocrinus* and fish beds of Spurgen Hill, Indiana. The arms, and in the absence of these, the general form, especially the button-like projecting base, distinguish this from *Actinocrinus*.

Dimensions of medium sized specimen.

Height from base to foot of proboscis,	1·45 inch.
Height of calyx to free arms,	·45 "
Diameter at free arms,	1·7 "
" " base,	·50 "
" of "	·65 "
Height of base,	·10 "

MEGISTOCRINUS, Owen and Shumard.

Megistocrinus rugosus, sp. nobis.

Body subglobose, truncated; below the truncation concave: from the second radials to the summit it is subcylindrical, thence assuming an unsymetrical, subconoidal form; surmounted by a long proboscis. The pieces of the calyx being ornamented with very prominent angular tubercles, give it an exceedingly rugose appearance, hence its specific name.

Column round, composed of alternate thicker and thinner pieces, the thinner ones being broader than the others.

Articulating surfaces marked by very short striæ confined to the outer margin, canal pentapetalous.

Basal pieces, three, forming together an irregular hexagon, the longest diameter of which is parallel to the anal side. The first facet of the column covers nearly four-fifths of the base: outside of this facet, these edges are finely granulated.

First radials, five, forming together with the first anal piece a circle of very symmetrical hexagonal pieces. Their surfaces are beautifully ornamented with striæ disposed hexagonally and interspersed with granular markings.

Second radials, five, also hexagonal though not so regular in form as the preceding ones. That portion of their surface lying nearest to the first radials is generally ornamented with fine granular markings, whilst the portion joining the third radials is strongly tuberculated, this peculiarity together with the comparatively smooth surfaces of the basal pieces, first and second radials, and the intervening interradials, forms a striking contrast with the rough sides and prominent thorns of the upper surface of our species.

Third radials, five, generally irregularly hexagonal, thick, tuberculated, axillary, and support each two brachials. In three of the rays they are axillary, and support on each facet one or two pieces, from which proceed the free arms, each ray thus supporting four arms. In the two remaining rays they are also axillary and support one or two pieces each, the ray having only one pair of arms, thus making in all sixteen arms. This disposition of the number of arms in a ray is constant and characteristic.

Interradials. These vary in adult specimens from thirteen to fifteen, in younger ones we generally find seven or eight. The first three or four pieces of the interradial fields are hexagonal. Situated between the radials, which they resemble in size, form and ornament, the remaining pieces of these fields become gradually smaller, and are less regular in their form and disposition. All of these as well as the other pieces forming the sides of the calyx are very thick, and ornamented by prominent arm bones, or boss-like projections. They are joined together only at their lower edges, the upper portion of each piece being free and separated from the contiguous one by deep sulculi.

Anal pieces, fifteen to twenty-five, varying with the age of the specimen; presenting much the same character as the interradials just mentioned. The one resting on the base is equal in size to the first radials which it resembles, this is succeeded by three large hexagonal pieces, nearly in a line with the second radials, the remainder are smaller and irregularly disposed.

Interbrachials. Between the brachials, and in a line with the radials, are interbrachial pieces, one large and two smaller pieces. In the second bifurcation, in those rays having four arms, and between the last brachials, there is generally one other interbrachial interposed, sometimes two or three. The arms are sixteen in number running off in two pairs of two, and three sets of four.

Vault. The vault is covered by small polygonal pieces arranged in clusters of seven to ten about a central one, which is usually larger than the surrounding pieces, and usually spinigerous. With the exception of the spines, the vault is devoid of ornament. The pieces are raised in the centre giving this part a varicose appearance. The proboscis is long, subcentral, composed of pieces similar to those of the vault; at or near the base of it is a spine which is nearly central, or somewhat larger than any other spine upon the summit.

Geological position and locality. This magnificent crinoid is found in considerable numbers in rocks of the Devonian period, a few feet beneath the black slate, at the quarries on Bear grass Creek near Louisville, Ky. We have referred this fossil to the genus *megistocrinus*, which it resembles so closely in the number and arrangement of the pieces that such disposition of it will hardly be questioned. It is found in the Devonian rocks of the age of the Hamilton group, associated with *Orthis suborbicularis*, *Atrypa reticularis*, *A. aspera*, *Euomphalus cyclostomus?* &c. This is about the same horizon in which Hall found his *Megistocrinus latus*. A fossil closely allied to this is found in the Devonian rocks of Spain, and described by De Verneuil as *Pradocrinus Baylii*,* a second species *P. Americanus*, is found on the Falls of the Ohio.

* Bulletin de la Geol. Soc. de France, 2d Series, t. vii, p. 137, pl. 2, fig. 11.

CYATHOCRINUS, Miller.

Cyathocrinus multibrachiatus, sp. nobis.

Calyx, vasiform, the pieces thick and tumid, surface ornamented with confluent granulose markings. Column, round, proportionally small.

Basals, five, pentagonal rather large; their under surfaces are scooped out forming a patelloid excavation which is entirely overspread by the column. Their superior margins are prolonged into angles.

Subradials, five, fitting into the retreating angles of the basis, four of them are hexagonal, the fifth, the anal piece, is heptagonal. Of these pieces the two postero-lateral ones are larger than the two antero-lateral one; the anal piece is yet larger and longer than any of the remainder. From the prominent centre of each piece, broad plications, vaguely marked proceed to the margins.

First radials, five, generally pentagonal, their width double their height, ornature same as on the other pieces, their upper edges are bevilled, near the centre of each of these edges is a cicatrix bounded by a strong thick margin, which occupies from one-third to one-half of the width of the piece, these support the remaining radial pieces which vary in different rays from two to seven in number, they are very irregular in size though usually wider than high.

Anal pieces, two, the first is obscurely heptagonal, larger than any of the other pieces of the calyx, succeeded by a small parallelogramic piece which forms the basis of the proboscis.

Vault. The form of the pieces composing the vault is unknown. The proboscis is excentric, occupies about one-third of the whole summit and is composed of small irregular hexagonal pieces whose surfaces are thickly studded with fine granulæ. Its length equals the height of the calyx.

Arms. From the last radial pieces of each ray there extend laterally two strong branches, each of which give off five or six smaller ones, these become subdivided and decrease regularly in size as they proceed from the axillary radials: this arrangement can be perceived only when portions of the arms have been removed, as they interlace and overlap each other. The pieces composing the arms have a parallelogramic form, their places of articulation marked by an elevated rim, surfaces otherwise perfectly smooth. We may readily suppose that at their final development the arms number from one hundred to one hundred and twenty.

Our specimen resembles *Cyathocrinus intermedius* of Hall (Iowa, p. 627, pl. 18, fig. 10), yet the differences are so marked that they will be easily distinguished.

Position and locality. Found in the subcarboniferous beds of Montgomery Co., Indiana, associated with *Forbesiocrinus*, *Platycrinus*, *Goniasteroidocrinus* and other crinoidal remains similar to those of the Keokuck limestone of Iowa.

Cyathocrinus multibrachiatus, var.

The basal, subradial, radial and anal pieces have the same form, relative size and position as in *C. multibrachiatus*. In the specimen figured the surfaces of all the pieces forming the calyx are destitute of any markings, wanting entirely the plications and granular ornature found on the

species above referred to; although this is true of another specimen in our collection, we suppose it owing to the imperfect conservation of those particular specimens rather than a constant characteristic of the variety. The principal differences are in the arms and the proboscis. The pieces composing the proboscis of the variety are arranged in parallel rows instead of alternating with each other as they do in *C. multibrachiatus*. The arms of the variety come off as in the species, namely, the last radial piece which is axillary, supports two rays of arms, but the secondary branches such as noticed in the description of the species continue in most instances throughout their whole length without bifurcations. This arrangement will be easily understood by reference to plate 5,* fig. *b*, 1, 2.

Position and locality. This crinoid occurs in the same beds as its congener described above.

ART. XXX.—*Contributions to Mineralogy;* by FREDK. A. GENTH.

1. *Native Iron.*

ABOUT four years ago I received for examination a mineral, which was said to be found in the neighborhood of Knoxville, Tennessee, in considerable quantities, and which was believed to be a valuable nickel ore. A qualitative analysis of it, made at that time, proved it to be almost pure iron, and the total absence of carbon, phosphorus and sulphur, and its peculiar appearance, made it very probable that it was *real native iron*. The specimen, which I received was $1\frac{1}{2} \times 1\frac{1}{2}$ in size, on one side of it the iron was $\frac{1}{4}$th, on the other $\frac{1}{8}$th of an inch in thickness; on one side it was incrusted by a silicate of iron, magnesia and lime.

The iron itself is of a greyish white color, a hackly fracture, and breaks easily into fragments of an irregular shape, which are crystalline, without, however, showing signs of any distinct planes. It is soft and scratches fluorspar with difficulty. Lustre eminently metalic. Dissolves readily in nitric acid. It was found to contain:

Iron,	99·790
Nickel, with a trace of Cobalt,	·140
Magnesium,	0·022
Calcium,	0·121
Silicium,	0·075
	100·148

About a year after I had examined the mineral from Knoxville, I received the *same* substance from northern Alabama as an alloy of gold, platinum, silver, copper, etc., with the request to advise a plan for the separation of these metals.

I have endeavored to obtain more of this interesting substance from both localities, but the parties, probably not being satisfied

* To be given hereafter.

with the results of my examinations, did not comply with my request, and I hope others may be more successful than I have been.

2. *Native Bismuth.*

A fragment of the beautiful variety of Bismuth from the Peak of the Sorato, in Bolivia, S. A., where it occurs in masses of a broadly laminated structure, the foliæ frequently interlaminated with films of native gold, has been presented to me by Chas. M. Wheatley, Esq., and was found to contain:

Bismuth,	99·914
Tellurium,	0·042
Iron,	*trace*
	99·956

3. *Whitneyite.* Am. Journ. Sci., [2], xxvii, 400.

In his Report on Lake Superior, Washington, 1849, p. 447, Dr. C. T. Jackson makes the following observations. "Aug. 3d, 1848. Crossing over the summit of the cliff and descending a few rods on the slope, we came to a little vein, which was supposed to be antimonial copper ore, but which, by blowpipe analysis, gave only arsenic and copper." This passage having escaped my notice at the time of writing my paper, I have not done Dr. Jackson full justice before. It is very probable that Dr. Jackson had my new species (Whitneyite) in his hands as early as Aug. 3d, 1848, (although he having failed to give an analysis of the same, there is no positive evidence of it). It is certain that he had a mineral, in which by blowpipe tests he found *only* arsenic and copper; but he does not express his opinion about it or its claims as a mineralogical species—and therefore, if he has been aware of the true nature of this interesting mineral, he has done an injustice to himself and science by not publishing his views about it.

So learned an investigator as Dr. Jackson could not have been ignorant that it was Domeyko, who first in 1843, described and analyzed the mineral which bears his name and proved the existence of arsenids of copper in nature which had not been recognized by Faraday, and von Kobell by their analyses of the same mineral in its impure and partly oxydized state of condurrite.

It is by no means certain, however, that the mineral noticed by Dr. Jackson, in 1848, was not the arsenid of nickel and copper noticed in this Journal, [2], xix, 417, by T. S. Hunt, and again on p. 15, this vol., by Prof. Whitney.

4. *Barnhardtite.*

This species, of which Breithaupt under the name of Homichlin gives a great many localities, promised, when first observed, to become a very important copper ore of North Carolina; it

has, however, not been observed since in its *pure state.* The localities Phœnix and Vanderburgh mines, mentioned by Otto Dieffenbach, are extremely doubtful, the specimens, which came to my notice from there, were only tarnished chalcopyrite; the Barnhardt mine has proved to be worthless, and is exhausted, whilst the ores from the Pioneer Mills mine, which I have from time to time obtained, were mostly the mineral mentioned in my paper, Am. Jour. Sci. [2], xix, 18, as containing about 40 p. c. of copper, or mixtures of chalcopyrite and barnhardtite with copperglance, which latter could be easily distinguished with a good magnifier in small veins, running through the whole mass, whilst the barnhardtite, previously examined, was quite homogeneous. The mixtures of copperglance with barnhardtite and chalcopyrite, as well as the barnhardtite itself, are interesting results of a peculiar decomposition of chalcopyrite, in which two equivalents of the latter are in action, and after the oxydation of the sesquisulphid of iron of one equivalent, the subsulphid of copper, thus liberated, combined with the other equivalent of chalcopyrite. This oxydation of the sulphid of iron in copper ores and concentration of the copper, resulting from the same, bears an analogy with the peculiar roasting process at the Austrian copper work at Agordo, where an iron pyrites, containing about 2 p. c. of copper, is roasted in lumps of the size of a fist; the copper concentrates in the centre, forming compounds similar to the above mentioned 40 oz. copper ore, barnhardite and erubesite, whilst the crust is chiefly composed of sesquioxyd of iron.

5. *Gersdorffite.*

I have observed this mineral on a specimen of anglesite from Phœnixville, Pa., on which it forms an incrustation upon partially decomposed galena and zincblende, associated with quartz, chalcopyrite and covelline. The very small crystals are cubes with octahedral planes and, very rarely, those of the pentagonal dodecahedron, the latter frequently indicated by the striation of the cubical planes. B.B. it gave the reactions of sulphur, arsenic and cobalt; a nitric acid solution, however, showed the presence of a larger percentage of nickel than cobalt.

6. *Molybdate of Iron.*

I am indebted to Dr. D. D. Owen for some fragments of this mineral from Nevada City, California, and have made a few experiments with the same, but regret that the rarity of this substance prevented a fuller examination. That which could be scratched off the quartz was not quite pure and contained a trace of limonite. Dilute ammonia acted readily upon it and extracted *all* the molybdic acid, leaving behind the hydrated sesquioxyd of iron of a brown color. The sample examined gave 24·3 p. c.

of sesquioxyd of iron, some of which was *certainly* mechanically mixed with it. Dr. Owen found by his experiments 35 p. c. of sesquioxyd of iron—from which it appears that this substance exists in the mineral in variable quantities. This fact and the other that dilute ammonia extracts the molybdic acid easily and completely, leave very little doubt that the Nevada City mineral is a mechanical mixture of molybdine with limonite, although I will admit that no *positive* opinion can be formed about it, unless larger quantities of the pure mineral are subjected to repeated analyses.

7. *Albite.*

a. In a lot of gold ores from California, which were sent to me for examination, I found a peculiar variety from the metamorphic slates of Calaveras county, consisting of a granular variety of albite, calcite, quartz and a talcose or chloritic mineral, mixed with auriferous pyrites and frequently with visible gold, and worked at Angel's, Major Fritz's, Dr. Hill's and Winter's mines. The albite showed sometimes a sublaminated and somewhat divergent structure, but only, where calcite predominated and could be removed by acid, crystals could be obtained. They were small and indistinct, showed however the common form or twins of the same. The following planes are noticed: *I*, *I'*, 1, 1', *O* and *i*$\breve{i}$. I analyzed a specimen of the granular variety, freed from calcite by dilute chlorhydric acid, and found:

		By J. L. Smith's method.
Silicic acid,	68·39	....
Alumina,	19·65	....
Sesquioxyd of iron,	0·41	....
Lime,	0·47	....
Soda,	10·97	10·53
Potash,	*trace*	*trace*
Ignition,	0·21	....
	100·10	

b. A massive greyish white variety of albite, much resembling petrosilex and some kinds of jasper, from the Steele mine, Montgomery county, N. C., has been examined in my laboratory by Mr. J. P. Pöpplein, who found it to contain:

Silicic acid,	60·29
Alumina,	19·66
Sesquioxyd of iron,	4·63
Oxyd of manganese,	*trace*
Magnesia,	0·23
Lime,	1·83
Soda,	9·90
Potash,	1·71
Water,	1·20
	99·45

For the determination of the alkalies, the albite, both from the Steele mine and California, were decomposed by fluohydric acid.

Although the material for this analysis appeared to be quite pure and homogeneous, the already commenced alteration of this mineral is indicated by the low percentage of silicic acid, the presence of water, etc.

It is rarely associated with crystals of albite, but frequently with minute crystals of orthoclase, sphene, ripidolite, gold, pyrites, blende, chalcopyrite and galena.

8. *Ripidolite.*

The most interesting associate of the massive albite from the Steele mine is ripidolite, because it is the result of its alteration, as can be easily observed from the fact that, wherever the albite has a crack, through which water could penetrate more readily, a greenish line makes its appearance, which indicates the commencing change; where this has already made more progrsss, it can be seen that the ripidolite is lining both sides of the fissures, whence it frequently extends through larger masses, which are not rarely completely converted into it, but sometimes contain a nucleus of albite, often having the diminutive shape of the original piece.

In cavities it is rarely observed in wormlike aggregations of microscopic crystals, sometimes in peculiar casts,* having the appearance of crystals, but generally in masses of aggregated scales of a dark olive green color.

* Prof. J. D. Dana, who had the kindness to examine these casts, makes the following remarks in a letter, dated New Haven, June 23, 1859:

"I doubt their being pseudomorphs for the following reasons:

1. The even manner, in which they are often cut through, and the variety of directions, looking as if the cuts were due to crystalline plates that have been removed;

2. The fact that the cuts sometimes go only half way through the pseudo-crystals;

3. The irregularity of form presented; for although the surfaces are flat, there is no symmetry in the arrangement of the planes.

4. The surfaces large and small in nearly all cases are marked with equilateral triangles; while if they were true pseudomorphs, retaining the markings of the original crystal, they would be confined to planes of one kind; that is, if rectangular prisms, they might possibly occur in one pair of the faces, but would not also on the others at the same time, and much less would they be found on the planes replacing the angle. Moreover such regular triangles look as if the system of crystallization was rhombohedral or monometric, while the forms are very far from either.

5. In the largest pseudo-crystal there is a piece of the rock projecting on one side. Now this projecting piece has its margin for a breadth of nearly a line smoothly flattened into the same plane with the face of the crystal,—seeming to show that both the face of the crystal and this flattened surface of the rock were made by pressure against a flat surface of another crystal. Such triangles on all the faces, in connection with the other particulars mentioned, appear to me to show that there must have been originally intersecting crystalline plates with angular cavities between, and that the ripidolite occupies these cavities; if such plates were triangularly marked they would have impressed the triangles alike on all the faces of the ripidolite, filling the cavities. The difficulty in this view of the case is this—that such triangles do not occur on any mineral that I can suggest as the probable cause. They are found on some foliated chlorite, ripidolite, clinochlore and pyroclerite, but what else?

I confess that I do not fully understand the ripidolite."

I found the pure mineral to contain:

Silicic acid,	24·90	contains	12·93	oxygen	= 1·20
Alumina,	21·77	"	10·17	11·55	1·08
Sesquioxyd of iron,	4·60	"	1·38		
Oxyd of iron,	24·21	"	5·37	10·74	1·
Oxyd of manganese,	1·15	"	0·26		
Magnesia,	12·78	"	5·11		
Water,	10·59	"	9·41		0·87

The oxygen ratio of $RO : R_2O_3 : SiO_3 : HO$ being 1 : 1·08 : 1·20 : 0·87, the ratio of the equivalents would be = 12 : 4 : 5 : 10, and considering alumina and sesquioxyd of iron as replacing silicic acid the formula $= 3\dot{R}_4\left(\frac{\ddot{S}i}{\ddot{R}}\right)_3 + 10\dot{H}$, or perhaps better $= \dot{R}_4\left(\frac{\ddot{S}i}{\ddot{R}}\right)_3 + 3\dot{H}$.

9. *Pholerite.*

A mineral has been observed in several of the coal mines of Schuylkill county, Pa., under similar circumstances to those, under which pholerite has been found in France and Belgium, that, their physical properties being the same, I consider them identical, notwithstanding the differences between my own and Guillemin's analyses.

At Tamaqua it is found in scales of a yellowish white color, which, however, can be easily removed by dilute chlorhydric acid, and near Pottsville in snow white nacreous scales of a pearly lustre.

Under the microscope the scales appear to be clinorhombic with the planes $\breve{a}$ predominating and $-1\breve{i}$ indicated by the truncation of the acute basal edge of the right rhomboidal prism.

I have made several analyses of the mineral from Tamaqua, both in its original state and after purifications by dilute chlorhydric acid.

The analyses were made by fusion with carbonate of soda, as well as with concentrated sulphuric acid; the silicic acid separated by the latter method dissolved completely in boiling carbonate of soda. The alkalies were determined by J. Lawrence Smith's method:

	I.	II.	III.	IV.
	Original Mineral.	Extracted by Chlorhydric Acid.		Calculated.
	By $NaO.CO_2$	By $NaO\,CO_2$	By $HO\,SO_3$	$\dot{X}l_3\,\ddot{S}i_4 + 6\dot{H}$
Silicic acid,	= 46·93	46·98	46·81	47·06
Alumina,	37·90	39·65	39·56	39·20
Sesquioxyd of iron,	0·18	——	——	——
Lime,	0·93	——	——	——
Soda,	Not determined.	0·11	0·11	——
Potash,		0·06	0·06	——
Water,	13·98	13·69	13·91	13·71
	99·92	100·49	100·45	100·00

These analyses show that many of the varieties of the so-called kaolin belong to pholerite.

10. *Scheelite.*

I have observed in North Carolina several new localities of this mineral.

a. At the so-called Dutchmen Vein of the Bangle mine property, Cabarras county, it has been met with between 90 and 100 feet depth, associated with pyrites and chalcopyrite in quartz; forming an ore, which contains from 2 to 3 ounces of fine gold in 2000 pounds. Although it is considerably disseminated through the whole mass of ore in fine grains, the largest masses, which I have seen were not over $\frac{1}{4}$ths of an inch in diameter.

No crystals have been noticed, but only granular masses of a pale yellowish brown color, distinctly showing the octahedral cleavage. It contains:

Binoxyd of tin,	0·13
Tungstic acid,	79·52
Oxyd of copper,	0·08
Sesquioxyd of iron,	0·18
Lime,	19·31
	99·22

b. Another locality is at the Flowe mine, Mecklenburgh county, N. C., where it is associated with barytes, chalybite, pyrites, chalcopyrite, wolfram and rhombic tungstate of lime.

Not more than two crystals have been observed; the first being a modification of the octahedron $\dot{1}$, slightly truncated by $1\dot{i}$. It has a yellowish brown color and would, if perfect, have a length of $\frac{3}{16}$ of one inch; the other crystal was about half that size, had a fine orange color and was a combination of the planes $\frac{1}{2}$ and $i\dot{i}$; it contained a small quantity of *tungstate of baryta.* Both crystals gave B.B. traces of tin.

11. *Rhombic Tungstate of Lime.*

Found also at the Flowe Mine.

It has a yellowish and greyish white color, and a vitreous lustre, which is subadamantine on a fresh fracture.

The crystals are small and indistinct, an aggregation of many individuals frequently formed into one crystal; the largest one, which I have seen, but which was very imperfect, was $\frac{1}{4}$th of an inch long. All crystals contain a nucleus of wolfram. I have noticed the following planes: *I*, $i\bar{i}$, $\frac{1}{2}\bar{i}$, 1 and $1\bar{i}$; cleavage could not be observed.

Are these crystals pseudomorphs? I do not believe it, at any rate, they have not the appearance of pseudomorphs. We know that lime is isomorphous with oxyd of iron and manganese, I would therefore suggest that tungstate of lime is *dimorphous*, and that in this case it is coating a nucleus of $\binom{Fe}{Mn}O, WO_3$, just like a chrome-alum crystal, when placed into a solution of alum,

deposites upon itself a coating of the latter, or in the same manner, in which the green tourmaline, of Chesterfield, Mass., surrounds a nucleus of the red. I do not think that ever anybody considered the green a pseudomorph of the red one?

12. *Wolfram.*

I have examined the wolfram, which forms the nucleus of the rhombic tungstate of lime.

Only one crystal has been observed yet, which shows the planes I, $i\bar{1}$, $\frac{1}{2}i\bar{1}$ and $1\bar{1}$. Sp. grav. at 25° Cels. = 7·496. It contains:

Tungstic acid,	75·79
Oxyd of iron,	19·80
Oxyd of manganese,	5·35
Lime,	0·32
Binoxyd of tin,	trace
	101·26

This corresponds with the formula: $4FeO, WO_3 + MnO, WO_3$.

13. *A few observations on the occurrence of Gold.*

Much has been said and written about the occurrence of gold in veins and elsewhere and the formation of the same, but comparing the different theories with some very important facts, we are often at a loss to explain the latter satisfactorily, and it seems to me that we know but very little about this difficult subject. Without any intention to discuss the merits of the different theories, I will give in the following a few data, which may help to throw some light on this question.

Gold is frequently found in diorite (in smaller quantities in syenite and granite) and although it is only rarely observed in the massive rocks, I have seen specimens from Honduras, C. A., where it was imbedded in the diorite without any other association. The result of the complete decomposition of the diorite is generally a red clayish soil and this has in the gold region of North Carolina, etc., a high reputation for its richness in gold. It was in the diorite region of Cabarrus County, N. C., where the first large piece of gold was found, weighing twenty-eight pounds. All this soil is more or less auriferous, but containing the gold somewhat concentrated, nearly in the same ratio, in which the lighter particles have been washed away. But not only in this country the diorite has been found to be auriferous, as is proved by the large piece of eighty-six pounds which was found at Alexandrowsk near Miask in Siberia, nine feet below the surface, in diorite.

The gold obtained from the disintegrated diorite is generally smooth and rounded as if it was water-worn. This cannot be, however, because it lies still in its original, but only altered matrix, and has not been subjected to any attrition by water and

sand; besides, if we observe any cavities in such gold, we find the sharp edges of crystals, etc., in the same, rounded in a similar manner, just as if the whole piece had been subjected to the action of acids, which in reality seems to have been the case. I believe that this is the most natural explanation, because it tells us at the same time, to what source we must trace the gold, which we find in the veins passing through these formations.

The greatest difficulty presents itself by inquiring into the nature of the solvent. I do not believe it is very probable that the gold has been carried off as a silicate of gold, or by the action of chlorhydric acid upon the sulphid. What seems to me most reasonable, is that it was dissolved as terchlorid of gold. If we remember, that the decomposition of pyrites, one of the most common accessory constituents of diorite, produces sulphuric acid, which in the presence of the never wanting chlorid of sodium and an higher oxyd of manganese may liberate small quantities of chlorine, the most powerful solvent of gold, we have at least a very plausible explanation.

After penetrating the decomposed diorite the solution of gold, passing down the veins, comes in contact with reducing agents and is reprecipitated again, frequently in crystals or crystalline forms. I shall farther below make a few remarks about the substances which precipitate the gold, in veins as well as in beds.

An almost positive proof that the gold in the veins of the diorite formation originates from the adjoining rocks is the fact that the deeper the diorite is decomposed, the deeper the gold is found in the veins. Many of these veins do not contain any gold at fifty feet depth, and I have known veins, which were rich near the surface, not to contain a trace of gold at thirty-five feet depth. Very few of these veins (if not on high hills) carry any gold below 120 feet depth.

The occurrence of gold in beds in the metamorphic slates at great depth can far more be relied upon; Gold Hill, in Rowan Co. N. C., for instance, is over 600 feet deep and the ore as rich as ever. Although it cannot be denied that the greater portion of the gold in such deposits is as old as the stratum itself, in which it occurs, it is certain that inside of such auriferous strata constant changes are going on, gold dissolved and reprecipitated. We could not account for the crystalline structure of most of the gold in such beds if we would not presume that the freshly precipitated gold deposits frequently *upon* that already present.

The description of a few specimens in my collection may be interesting, for they prove that the gold *must* have been in solution.

a. From Whitehall, Spotsylvania Co. Va.,—shows gold associated with tetradymite, limonite and quartz. The gold is crystallized in forms belonging to the rhombohedral system and

showing very distinctly one rhombohedron, scalenohedron and basal plan; it is coating tetradymite and evidently a pseudomorph after it. I have seen other specimens from the same locality, but of inferior value and beauty.

b. The tetradymite from the Tellurium Mine, Fluvanna Co. Va., and the native bismuth from the Peak of the Sorato in Bolivia, S. A., are frequently interlaminated with gold.

I have made some experiments with a solution of terchlorid of gold and tetradymite and found that the latter precipitates the gold from a dilute solution easily with a smooth and brilliant surface.

c. In the upper portion of the ore bed in the metamorphic slates at Springfield, Carroll county, Md., which, near the surface, consists of magnetite and at a greater depth of chalcopyrite and other ores, sometimes films of native gold have been observed coating the cleavage planes of magnetite. On close examination it can be noticed that below the film of gold the magnetite is oxydized into hydrated sesquioxyd of iron.

d. A very striking occurrence of native gold is, that where it is associated with pyrites. Most of the pyritous gold ores are too poor to form a positive opinion about the form, in which they contain the gold, from observation, and many authors are of opinion that the gold may exist in the form of a sulphid, either by itself or as a sulphosalt. If we take it for granted that the pyrites itself is the result of the reduction of iron-salts and bear in mind that protosalts of iron reduce gold *instantaneously*, we cannot adopt this opinion. But even if terchlorid of gold should have been precipitated by sulphydric acid, whilst passing through the vein, it could not remain in that state for a long time, because moist tersulphid of gold in the presence of the smallest trace of an acid is easily decomposed into metallic gold and sulphuric acid. Some specimens of auriferous albite from Winter's vein, Calaveras county, California, show beautifully that, wherever there is a crystal of pyrites, small crystals of gold are attached to it, demonstrating, that the sulphate of iron precipitated the gold, previous to its own reduction into pyrites.

All these facts prove that the gold is carried into the veins from the adjoining rocks, and that the opinion, which considers veins the source of the gold of alluvial and diluvial deposits and the soil, is erroneous.

If another proof was wanted to show the fallacy of this idea, it would be the fact that the gold from the soil or alluvial and diluvial deposits, has rarely the same fineness as that from the veins wrought in the immediate neighborhood of the same, the latter being generally less fine. It is impossible therefore that the destruction of a portion of these veins could have furnished the gold of such deposits.

Philadelphia, July 27, 1859.

ART. XXXI.—*Notice of a Memoir by M. Jules Marcou, entitled "Dyas and Trias or the New Red Sandstone in Europe, North America and India."** (In a letter from Sir RODERICK I. MURCHISON to the Editors.)

Gentlemen—

IN the early part of last winter I read with surprise the following paragraph in a published letter by M. Jules Marcou on American Geology. "I think that the term Permian, at least as given by Murchison for the strata of the government of Perm, a very improper one. There are strong suspicions that Murchison has put into his Permian a part if not the whole of the Trias, and I am almost certain that if geologists accept the Russian Permian as Murchison has defined it as the type, the Trias will disappear from classification in Asia, Africa, America, and Australia."

Considering this to be a serious charge, I wrote to M. Marcou and begged to know the grounds on which he had made it. As he had never been in Russia, I called his notice to another expression in his own letter on American geology in which he says: "not having visited Kansas or Nebraska I have no decided opinion respecting the geology of those countries; for I profess the doctrine that geologists must see with their own eyes," &c. I further expressed a wish, that M. Marcou had acted on his own doctrine, as respected Russia, before he passed so severe a judgment on the researches of M. de Verneuil, Count Keyserling and myself. The replies sent to me by that gentleman, though very polite, being by no means satisfactory, I stated to him my intention of publishing our correspondence in your journal. But I abstained to do so until M. Marcou had produced a fuller explanation of his views.

After a study of the original work of my friends and self, M. Marcou has at length produced his results in the Bibliothèque Universelle de Genève under the title of which a translation is given at the head of this letter.

Leaving my able contemporaries in America and the Geological Surveyors in India to settle their accounts with M. Marcou, I have requested my coadjutor, M. de Verneuil, to answer this article in the French language. In the mean time I confidently refer the judgment of the value of this critical essay to all geologists who have followed the progress of their science.

All such persons know, and particularly those who have read the new edition of my work on Siluria, that the absolute distinction between the fossils of the Permian group or *Dyas* of M. Marcou and those of the Trias is much more sharply defined

* Bibliothèque Universelle de Genève, Mai et Juin, 1859.

than ever, and yet he reverts to the former and obsolete state of the science and merges these two most markedly separated deposits in one natural group. The author applies his new word 'Dyas' to the rocks in question because the two deposits only of Rothe-liegende and Zechstein chiefly prevail in certain tracts; but geologists who have gone through all the proofs I have adduced from various countries of a clear division of the Permian rocks into three parts, of which Zechstein is the centre, will not easily be led to adopt the use of the new word—still less to mix up as proposed the Dyas and Trias in one geological group.

Although I will not answer objections in detail on the geology of Russia which proceed from a writer who has never been in that country, let me inform those of your readers who are in the same condition as M. Marcou, that one of the very reasons he assigns to depreciate the correctness of my ultimate classification, ought to operate in my favor. It is quite true that in most parts of the vast region of Russia (larger than France) occupied by the rocks to which I assigned the name of Permian, there is no large development at their base, of those deposits which in Germany are known as the Roth-todt-liegende, though even in Russia there are tracts in which underlying grits with plants represent that German deposit. But the great fact which I established by visits to all the classical districts of Germany before the publication of the work on Russia and by comparing them with those of Russia is, that whether the pebble-beds and sandstones underlie the Zechstein as in Germany or are intermixed with and chiefly overlie all the limestone as in Russia, the plants of the two regions have been pronounced to be identical. These plants are related generically to the Carboniferous forms, whilst on the authority of Göppert they are pronounced to be entirely distinct from those of the Trias.

In short, the whole geological series does not offer a more complete discordance of type between any two conterminous groups than that which exists between the fossils of the Permian and those of the Trias, whether we refer to their respectively imbedded reptiles, fishes and shells, or to their plants; the one set marking the close of Palæozoic, the others the commencement of the Mesozoic era. Yet these are the two deposits which M. Marcou unites in *one natural group* under the name of New Red Sandstone.

To conclude, let me request you, Messrs. Editors, to have the goodness to translate into English the concluding page of the memoir of M. Marcou, beginning "En resumé," &c., and I will then require no other reason to induce plain geologists to side with my associates and self, by retaining in the great palæozoic division of life, the inhabitants of the Permian era, and by op-

posing the views of an author who considers such fossils to be the remains of "precocious beings"—the 'precursors' or 'advanced guard' of the secondary or Mesozoic populations!"

I remain gentlemen, your very obedient servant,

RODERICK I. MURCHISON.

Geological Survey Office, London, July 25th, 1859.

P. S.—Informing his readers that my eminent friend M. d'Omalius d'Halloy had named the same rocks Penéen ('poor') which I afterwards termed Permian, M. Marcou should recollect, that when I wrote my first letter on the subject to Dr. Fischer at Moscow in 1842, I was far distant from any works of reference. When, however, I consulted the 'Eléments de Géologie' of d'Omalius, published in 1831, I found that although that sound geologist had widely separated his 'Penéen' from the 'Terrain Kuprique,' he still maintained as a part of the group the 'New Red Sandstone,' from which the Permian was specially distinguished. Moreover, I much preferred a purely geographical name taken from a country where fossils abounded, to a term which implied poverty of fossils. In fact, M. d'Omalius tells us (p. 276) that his name Penéen was intended as a French translation of Roht-todt-liegende, the examples of which rock, best known to the Nestor of Belgian geologists, near Malmedy, are indeed quite sterile, as I know from personal examination long before I visited Russia.

The following is the summary of Mr. Marcou, called for in the last paragraph of Sir R. I. Murchison's letter.—EDS.

"To sum up, I am led to regard the New Red Sandstone comprising the Dyas and Trias as a great geologic period, equal in time and space to the Palæozoic epoch, or the Graywackés (Silurian and Devonian), the Carboniferous (the Mountain Limestone and Coal Measures), the Mesozoic (Jurassic and Cretaceous), the Tertiary (Eocene, Miocene and Pliocene), and the recent deposits (Quaternary and later). I also restrict the limits ordinarily ascribed to the Palæozoic and the Mesozoic, and give them proportions more in harmony with those of the Tertiary and recent epoch—to the end that we may have a well balanced and natural classification.

"In the 'New Red' as well as in all other great epochs, we remark that the lower beds (the Roth-liegende) contain Carboniferous forms of life—a kind of '*rear guard*' of the populations whose destruction had commenced, indicating that there were some organisms endowed with a vital force superior to that given generally to other beings, permitting them to witness the disappearance of all their contemporaries, and at the same time to become the spectators—but *isolated spectators*, of the advent of new generations, which, although composed of beings somewhat

similar to their predecessors, are endowed nevertheless with other forms, and of necessity therefore with other habits, associations, and aspects—exactly like the centenary in our human societies. On the other hand, the upper beds of the New Red, such as the 'Halstatter Kalk,' the 'Raibler Schichten,' the 'Bone-bed,' or the Keuper contain forms indicating the approach of another geologic period of secondary beds (Jurassic and Cretaceous), beings which Professor Quenstedt has happily designated as the '*precursors*' or '*advance guard*' of the Mesozoic populations. Precocious beings, these precursors, recalling generally by their sudden appearances and disappearances, those comets which coming from time to time announce that great events are on the point of fulfillment. Or, better still, they may be compared to plants which, forced in hot-houses, flourish in the winter, in place of awaiting the spring and whose pale-tinted flowers, and etiolated or disproportioned forms, appear as if they knew that they were before their time, and as if it was only a species of tentative experiment, which they were performing and so they hastened to disappear to make room for the vigorous and abundant flora of the warm season."—*Bibliothèque Universelle* (*de Genève*), Juin 20, 1859, pp. 145, 146.

[*Obs.* It will be interesting for the reader to turn from Mr. Marcou's "rear guards, isolated spectators," and "advance guards," to the plain prose of facts observed by Dr. Newberry in New Mexico, on the site of our author's assumed Jurassic beds. See p. 298.]

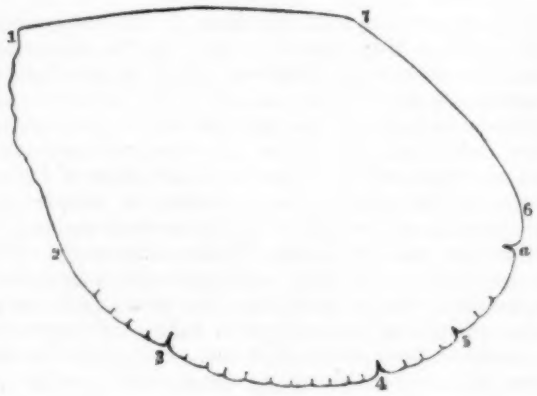
ART. XXXII.—*Examination of a supposed Meteoric Iron, found near Rutherfordton, North Carolina;* by CHARLES UPHAM SHEPARD.

FOR my first knowledge of this Iron, I am indebted to Dr. Thomas S. Duffy of Rutherfordton, who in the winter of 1857 casually mentioned to me at Charleston, that he had been shown a very remarkable specimen of an ore found in his vicinity, of the character of which no one had been able to pronounce a satisfactory judgment. From his description of its lustre and color, and of certain striæ on one or more sides of the mass, I conceived it might prove a large crystal of mispickel. He was kind enough on his return home to send me in a letter, a few grains that had been chipped from the mass. These I found to be slightly malleable and magnetic, while they suffered no sensible alteration before the blowpipe;—properties that at once excited my curiosity, and led to my requesting Dr. Duff to purchase the specimen for me. Sometime elapsed before he was able to effect the object, chiefly owing to the removal of the original proprietor to a distance from Rutherford. In

November, 1858, however, he sent the specimen to me by the hand of Rev. Mr. Bowman; and a month after addressed me the following note, in reply to several interrogations I had propounded. "I have been considering the questions you asked me relative to the nondescript specimen I sent you by Mr. Bowman. It was ploughed up at the foot of a hill near a small water-course, named Sisemore Branch, about half a mile from where it empties into Second Broad River, and four miles from Rutherfordton. It was found by a man named Pinner, who has since removed to the southwest. Search was made, but no similar piece was discovered, although iron ore of good quality was found. There are no iron-works in the neighborhood. This is all the information I am able to communicate about a substance which has puzzled us all here. You will oblige me by retaining it in your possession, till I can say something definite as to its ownership."

My perplexity was greatly increased on the inspection of the mass. Its weight was three pounds and three quarters, and its specific gravity, 6·745. Its shape was imperfectly cylindrical; and it measured a little above three inches in length, by rather less than three in one of its diameters, and two in the other. It was moreover slightly tapering in its figure,—having evidently been broken directly and evenly across at each extremity, from connection with a longer mass, that may have been stalactitic in shape, or even drop-form, like the Charlotte meteoric iron, that was seen to fall August 1, 1835. Almost the first impression created by the fragment is, that it is cast-iron or steel, that has been run in a mould formed by a fossil Calamite, supposing also that the surface was afterwards perfectly cleared of any crust or film, and polished throughout at every point. Singular ver-

1.



tical striæ prevail on one side of the flattened cylinder, while on the other half, a totally different style of marking is visible.

The nearer the view however, the less striking is the resemblance to any species of casting: and the shape is seen to conform but very imperfectly to a section of a Calamite; for, strictly speaking, the mass is only semi-cylindric in figure, three-fifths of the remainder being flat, and the balance but slightly convex.

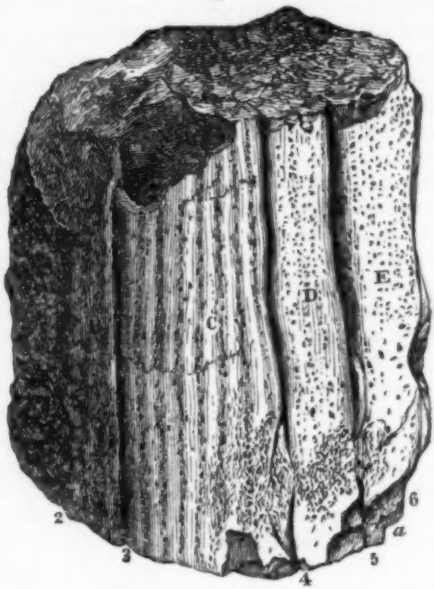
The first sketch presents an outline of the smaller base.

The same general figure would be afforded by cross-sections made at any point, between the base and summit of the mass; and it may therefore be employed to describe in part, the character of the sides of the cylinder. From 1 to 2 is a pitted, wavy, irregular surface, like that ordinarily seen on true meteorites. Between 2 and 5 is the most perfectly turned and smooth portion of the cylindric surface. Its symmetry is nearly complete, except for four vertical channels or grooves, one-sixteenth of an inch in depth and one-eighth across at top. These have convex sides which meet at bottom so as to touch without actual coalescence,—continuing distinct, though in apposition, for a depth of nearly one-tenth of an inch. In several places also the entire channel of the groove, for the distance of nearly an inch, is filled with the substance of the mineral, as if the matter had flowed into and filled it after the solidification of the sides. It is noticeable also, that the external surface of the matter thus introduced is exactly smoothed off, and pitted, to correspond to the rounded cylindric surface of the mass. These grooves occur at 3, 4, 5 and *a*. Between the grooves are numerous perfectly parallel and equidistant vertical lines, made up of slight punctures or depressions. The punctulated striæ are denoted as to number and position in the figure, by the inwardly projecting points. Other dots are here and there visible also upon the surfaces, intermediate between the punctulated lines, all of which are seen in the second diagram, where a full representation is given of the grooved semi-cylinder itself. Portions of the groove which have been filled up are seen near the bottom. The punctulated lines are denoted on B, C and D. They are less visible on E, while A is undulous and pitted, as in meteorites generally. The side of B, contiguous to A, has a character intermediate, between the broad-pitted and the punctulate.

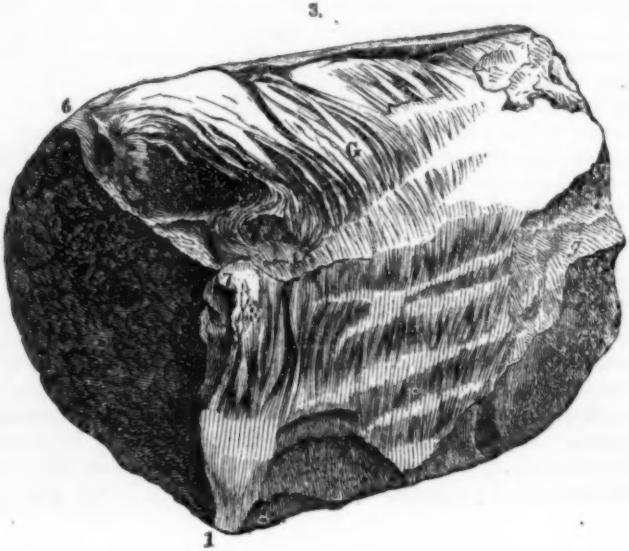
The opposite side (fig. 3) of the mass is perhaps the most anomalous in its markings. The flat surface F (from which a considerable fragment has been chipped off at *g*) is smooth, with the exception of a multitude of finely pectinated wrinkles, or wave-like elevations, which to the axis, are almost horizontally disposed. These are interrupted in their continuity by several nearly smooth spaces, or channels, running cross-wise from top to bottom, as if produced by the pressure of a broad gravure.

Other lines still more delicate come into view with the aid of a glass, forming a complication of patterns exceedingly delicate,

2.



3.



but too intricate for description. They do not however possess any analogy to the etchings on meteoric iron, steel or cast-iron.

The surface G at its uppermost portion (or to the right in the figure) is almost perfectly smooth, presenting only a faint resemblance to the flat side, in the presence of a few nearly obsolete wrinkles. At the middle region, however, these elevations become more strongly marked; while still lower down (to the left) they degenerate in regularity and pass into the pitted and undulous surface, as they form the interior of a crateriform cavity fully half an inch deep, by three quarters of an inch across at its opening. The appearance of this cavity at once suggests the idea that a blunt solid was thrust into the matter when nearly congealed, forcing it into the large wrinkles or waves which form the circumference of the crater. Indeed, it appears highly probable that all the undulations and crimpings, large and small, originated in the foreign body that produced this deep cavity. Very little stress however could be attached to an explanation of such various and unusual appearances as this mass presents, and I could venture upon no conjecture of its origin as a whole, more probable, than that the matter of which it is composed had flowed originally into a cavity in some earthy, refractory material, where it slowly suffered congelation, pressing with greater force perhaps against the walls of the cavity on the striated or semi-cylindric side than upon the other. In any case, it seems quite certain, that its formation occurred with entire exclusion of atmospheric air; and if a meteorite, it must have been protected by a covering of stony matter, until it reached the surface of the earth. The strangeness of external aspect was regarded as affording a certain degree of probability in favor of its meteoric origin; since all who have studied these productions attentively, have recognized in them traits, wholly inexplicable from our knowledge of merely terrestrial matter.

Chemical experiments soon proved that the mass was essentially composed of iron and silicon, with an unusually high proportion of the latter element; a discovery again, that pointed with some significancy towards a meteoric origin, provided the artificial source should also be rendered improbable: for up to this moment, no mineral belonging to our earth has presented silicon combined with any other element than oxygen. I hastened to communicate my result to Dr. Duffy, from whom I received (Jan. 1, 1859) the following additional information. "I had the pleasure of receiving yesterday, your note of the 27th ult. The account you give me of the mineral I sent you is very interesting. I beg you will accept of the mass from me. It was found in the spring of 1855. There is no evidence of iron ever having been made near the place. I shall be able to send you some iron-ore from the same locality, when an opportunity

occurs. The nearest place of iron manufacture is High Shoal (supposed to be twelve miles distant from where the specimen was found). Before I sent it to you, I showed it to several persons connected with this furnace; but they were all equally puzzled to make out what it was. The general conclusion arrived at being, that it was of a mineral character."

As yet I have received no specimens of the iron-ore said to be found at the spot. The geology of the region however is known to be primary, it being fully within the auriferous formation. It is probable that the occurrence of iron-ore at the spot is purely accidental, as such ore is widely distributed throughout the gold region of the southern states.

The supposed meteorite breaks with greater facility than cast-steel, first undergoing a slight condensation, if struck with the edge or the corner of a hammer. The fractured surface is somewhat even, of an iron-grey color, and yields feeble reflections of light in rather broad irregular patches, in shape most resembling those produced on a surface of a coarse-grained dolomite. Besides the broader patches of light from large foliated individuals, are others from frequent scaly points, that are much brighter. The lustre of the exterior is much higher, and the color is lighter also, than that of the fractured surface. Both are nearly identical with those of polished platinum, though the color inclines slightly to that of graphite.

The mass is not wholly without vesicular cavities; but these are very rare, and can scarcely be detected without the aid of a glass. One of them is quite round, with smooth, shining black walls, (probably enfilmed with black oxyd of iron) and another near by, which is elongate and irregular, contains a distinct particle of quartz or silica. It may be mentioned here, that several similar grains, but too minute for detection with the naked eye, were left after the solution of the other constituents of the mass in acids.

It nowhere shows the remains of any coating or crust, and is equally free from evincing the slightest tendency to oxydation or tarnish; and such is the delicacy of the raised lines, punctures and sinuses of the surface, it is impossible to believe that it ever had any such investiture.

The hardness is 7·5 on the mineralogical scale, scratching quartz quite easily, when its sharp angles are applied to rock crystal. A Sheffield cutler pronounced it harder by far, than any steel. He was unable to temper it. When suddenly heated and struck with a hammer, it flew to pieces like glass. A fractured surface was smoothed, and with some difficulty, etched with aqua regia. Its color (unlike to etched steel) was but slightly darkened; and the pattern developed was simply that of a coarse grained saccharoidal limestone, rubbed down to a surface on

sandstone and then moistened. It chips off under blows from the hammer into thin scales, which are easily crushed to powder in a steel mortar. It may then be ground to an impalpable powder in an agate mortar, with greater facility than many earthy minerals of inferior hardness.

The following observations, showing the remarkable passivity of this iron were next made. It is not attackable by dilute sulphuric acid. If previously reduced to powder, a very feeble action is set up, which proceeds with activity as soon as heat is applied. It does not precipitate copper from an acid solution of the cuprous sulphate. In nitric acid also, there is no action, unless the acid is concentrated and slightly warmed, when a few bubbles of binoxyd of nitrogen appear. The surface however does not become sensibly corroded. Hydrochloric acid gives rise to a coating of bubbles only; and if the mass was previously polished, its surface when washed and dried, is found to have grown a shade darker, and to have lost its metallic lustre, attended with the developement of imperfect lines of crystallization.

A few grammes in the state of powder were treated with hydrochloric acid at the temperature of 80°. The extrication of hydrogen gas was gradual, unattended by any sensible production of heat. The action was considerably promoted by slight agitation. On heating to 90°, the decomposition of the hydrochloric acid was much promoted; and the gas was tested, and found to be pure hydrogen.* After some hours, a strong yellowish green solution was obtained; and a film of the same color lined the flask for some distance above the level of the liquid. The flask being left in a state of rest for some time, fell in temperature to 65°; and its contents assumed a partially gelatinized form. On the slightest agitation, its consistency was somewhat dispersed, attended by a singular decrepitation, resembling the ticking of the water-hammer, on the agitation of the fluid in Wollaston's cryophorus. This continued as often as the flask was moved, for many minutes; and was unaccompanied by any sensible extrication of gas. The occurrence of this phenomenon was verified in several repetitions of the solution, and remains at present wholly without an explanation.

One portion of the solution was examined by sulphuretted hydrogen for other metals, without their detection. Another on being cleared of the iron, was found to contain faint traces of magnesium. The main portion of the hydrochloric solution, turbid with the imperfectly suspended silica, was transferred to a filter, upon which the latter was left in a voluminous state, and possessed a dark greyish tinge, as if from the presence of traces

* With strong hydrochloric acid at a lower temperature (say 65°) beautiful green tabular crystals are formed, supposed to be a hydrated double chlorid of iron and silicon.

of carbon (possibly also of silicon). The affusion of hot water produced an instantaneous effervescence, from the extrication of hydrogen. This was continued by subsequent additions, until the acid was almost completely removed, when the hydrated silica occupied the bottom of the filter, having a somewhat lighter shade of white, and on being turned out and broken up, was found to be filled with rounded, amygdaloidal cavities. This singular action of the hot water may proceed from the subversion of a compound present, consisting of the chlorid of silicon and hydrochloric acid, its decomposition being occasioned by the washing out of an excess of hydrochloric acid (aided by heat), —the new bodies eliminated being silicic acid, hydrochloric acid and hydrogen. Thus

$$SiCl, HCl+3HO=SiO^3, 2HCl+2H.$$

Or the effervescence may be occasioned simply by the decomposition of water (aided by heat), through the presence of free silicon.

The silica was so light as to require much care while drying it in a broad platinum capsule; and just prior to its ignition, a bright glow set for an instant through its entire mass, produced by the combustion of a trace of carbon.

The first determination of the proportions of the iron and silicon gave as follows:

Iron,	84·00
Silicon,	13·57

It occurred to me at this stage of the investigation to determine, whether a compound so rich in silicon would yield a pure chlorid of silicon, if chlorine were presented to it under favorable circumstances. Accordingly, a current of dry chlorine was transmitted over the powdered mineral in a glass tube, the reaction being aided by the heat of an alcoholic lamp. Arrangements were made for condensing the product in a letter U tube, surrounded by a freezing mixture. As soon as the chlorine began to traverse the heated powder, a brilliant red glow attended by scintillations in spots, appeared in the tube for the distance of half an inch (from the end nearest the source of the chlorine); and a dense yellowish smoke was emitted for a moment, from the exit tube. The action in the tube was kept up for several minutes. It now and then burst into an explosive combustion, and dashed an orange red vapor upon the tube, which was afterwards coated red-brown by a crystalline precipitate, and wetted also by a thin liquid that could not be forced to enter the cooling apparatus. At the close of the experiment, a very small quantity of a pale yellow liquid was found in the condensing tube. In this, a few drops of water produced hydrochloric acid and gelatinous silica. A portion of the liquid was also

tested after the precipitation of the silica for iron, unattended by its detection, even in the minutest trace. The volatile product was therefore considered as terchlorid of silicon.

But the charge in the tube which had suffered combustion, was found to be swollen to three times its original bulk; and was for the most part in beautifully perfect hexagonal crystals of a blood-red color, like the minute forms of volcanic hematite. These crystals were found to possess very remarkable properties, a few of which may here be mentioned.

The tube in which they were formed was carefully corked, so as to exclude the air. On allowing a few of them to fall into a dry test-tube, and held in the sun's rays, they turned a deep yellow with a tinge of green, and quickly coiled up and shrivelled,—at the same time, emitting a peculiar ethereal odor.

In the process of sealing hermetically the tube in which the crystals had been formed, a considerable jet of vapor issued from the heated end, and burned with a bright light, attended by a white smoke. As all moisture had not been excluded from the powder, it appeared probable that this combustion was partly to be ascribed to siliciuretted hydrogen; and the smoke was attributed to silicic acid.

The red crystals in the air, out of the sun's rays, deliquesce rapidly, forming a blood-red solution; and are soluble in ether and in water: ammonia throws down from either solution, a mixture of silicic acid and peroxyd of iron.

On heating the contents of the sealed tube to between 250° and 300°, the red crystals are speedily volatilized, and condense as quickly on cooler portions of the tube immediately contiguous, —the precipitated crystals filling the cavity of the tube, and performing the most extraordinary movements, like the gyrations of falling snow-flakes.

When the red crystals are heated in a tube with considerable access of air, they turn yellow, giving rise to a pale yellow vapor. This on cooling, leads to a greyish white coating on the glass, and the formation of a voluminous greyish powder, which on being treated with warm water partly dissolves, leaving silicic acid behind. The solution is precipitated by ammonia, of a bluish green color at first, but afterward turns to red brown. I am therefore led to regard the red crystals, as a compound of sesquichlorid of iron and chlorid of silicon; and suppose that the presence of air (aided by heat) changes it to one, of the protochlorids of iron and chlorid of silicon, with formation of silicic acid,—possibly to a compound of protochlorid of iron and silicic acid only.

The unusual results obtained rendered me desirous of communicating them for correction and advice, to Prof. Wöhler of Göttingen, a chemist who had especially occupied himself not only

with the analysis of meteorites, but with the study of silicon and its more difficult compounds. I accordingly forwarded to him an outline of my results, accompanied by a few grammes of the iron, and solicited his opinion upon the subject. He had the goodness to have an analysis performed for me under his eye, and to engage in some experiments himself upon the material sent.

The analysis afforded the following result:

Iron, - - - - - -	87·10
Silicon, - - - - -	10·60
Graphite, - - - - -	0·40
	98·10

Of which he remarks, that without claiming for it the most rigorous exactness, it is sufficiently accurate to show, that the composition of the mass is essentially a compound of Fe^6Si, or one of

Iron, - - - - - -	88·80
Silicon, - - - - -	11·20

(Silicic acid being assumed $=Si\,O^3$).

He then observes, that it subsequently occurred to him to examine the precipitated peroxyd of iron for phosphoric acid; and that he detected therein, a strongly pronounced proof of its existence. This discovery induced him further to say, that the presence of phosphorus points to its meteoric origin, notwithstanding the absence of nickel in the mass.

I have since made a determination of the phosphorus, and found it to amount to 1·312 p. c.; and combining the numbers of the calculated result upon the iron as being composed of Fe^6Si, and employing therewith Wöhler's determination of the carbon and my own of the phosphorus, the present statement is believed to be a close approximation to the composition of the Rutherfordton mass:

Iron, - - - - - -	87·279
Silicon, - - - - -	11·008
Phosphorus, - - - -	1·312
Carbon, - - - - -	0·400
Magnesium, - - - -	*trace*
	99·999

We recur once more to the question of its origin. It is admitted that it was found in a region containing iron ores, and that the manufacture of this metal had been carried on, though to a very limited extent, at the distance of ten or fifteen miles from the place of its discovery. It is with difficulty supposable that so considerable a mass of a compound before unknown in

chemistry or metallurgy should have originated in such a source. Karsten, the highest authority perhaps upon the products of iron furnaces, says, that the greatest quantity of silicon he ever found in raw iron (pig-metal) was 3·46 p. c.; and that this large proportion occurred under very rare circumstances. Stromeyer who studied the modes of combining iron in silicon with much care, succeeded in uniting them in proportions between 2·25 and 9·3 p. c. of silicon; but in the cases of the higher proportions of silicon, he found the carbon increased also steadily in the compound, to a very high per centage. It would hence appear, that the trifling amount of carbon in the Rutherford mineral, militates against the view of its furnace formation: nor is it probable that it originated in a refinery; for Karsten distinctly asserts, that in that process, the silicon is mostly separated and slagged off. Can it be a natural, terrestrial product, originating after the manner of a fulgurite? Heat enough has perhaps been produced, during the most powerful discharges of lightning to melt a mass of this size; but it remains for us to conceive of the electrolytic action, which should unlose and bring together from any rocks or minerals within our knowledge, such elements as are here found. As bearing upon its meteoric origin, however, we may adduce its peculiarity of shape and structure, the presence of phosphorus, silicon and magnesium,—all of which, as here combined, are eminently meteoric constituents. But as no body has been seen to fall from the skies possessing a similar constitution with the Rutherfordton mass, we are obliged for the present to admit, that the proof of an extra-terrestrial origin remains incomplete; though we may perhaps be allowed to claim, that the evidence already preponderates in this direction.

In a report on meteorites submitted by me to the American Association in 1848, I proposed an order of brittle, metallic meteorites, to provide a place for several examples then regarded by me as meteoric, viz: one from Randolph county North Carolina, another from Bedford county Pennsylvania, together with a third from Otsego county, New York,—this last differing from the first two in important respects as to composition, and which I placed in a section by itself, under the order. The two first mentioned agreed in not containing either of the substances then supposed to be characteristic of true meteors; while that from Otsego, possessed those constituents in the fullest manner. For these reasons, I have thought proper in my later printed catalogues of meteorites, to place the Randolph and Bedford localities among the doubtful meteoric irons, where their number has unexpectedly been augmented by the discovery in Montgomery, Vermont, of a third, possessing the same general properties. I may now add, that the Rutherfordton iron approaches much more nearly to each of the three, than to any other kind of matter with

which I am acquainted. Still I cannot pronounce them identical, though my very imperfect examination had enabled me to indicate silicon from the first, as a constituent of the Randolph specimen. They were each found under circumstances equally favorable as in the case of the Rutherford iron, to the idea of their being natural productions. But unfortunately, the size of the specimens was so small as to render their full elucidation difficult. Nevertheless, I hope very soon to subject them anew to examination; and I think I may add, with every probability of establishing the real existence of the group of meteoric irons originally proposed, but which has temporarily been withdrawn from my classification.

As a convenient name for the Rutherfordton species of matter, I would propose that of *Ferrosilicine.*

ART. XXXIII.—*On a Shooting Meteor, seen to fall at Charleston, South Carolina, on the evening of November 16th, 1857, with notices of other supposed shooting meteors;* by CHARLES UPHAM SHEPARD.

IN calling attention to the matter of a shooting meteor, I am conscious, that the evidence of its genuineness is not absolutely perfect; nevertheless, it falls so little short of entire satisfactoriness, as to make it fully worthy of notice. No instance of the kind at least, has yet been recorded, entitled to so much confidence. In detailing the circumstances, I shall aim to present every particular, precisely as it came to my knowledge.

Mr. Sparkman R. Scriven, aged about 17, and clerk in the dry goods store of Messrs. Browning & Ketchum of King street, Charleston, a young man of excellent character, was the principal observer of the phenomenon. He had just returned, at half past 8 in the evening of Nov. 16th, 1857, to the residence of his father (Mr. J. M. Scriven) in Morris street, three doors west of King, and having occasion to step into the portico, he saw a red, fiery ball of the size and shape of an orange, slowly descending through a distance apparently of 20 or 30 feet, to the ground. Its fall was scarcely more rapid than that of a soap bubble, giving him time to call his sister, a little girl, to see it strike a high wooden fence, distant about fifty or sixty feet from the portico, and which separated the door-yard from a church enclosure adjoining. It seemed to adhere for an instant to the board against which it struck, and then separated into three parts and disappeared. The evening was dark, it having followed a rainy afternoon, though at the time of the fall, it had ceased to rain and become very foggy.

Nothing further would probably have been heard of the phenomenon but for the accidental reading, by an elder sister the next day at the breakfast table, of a paragraph from the newspaper, relating to a meteoric fall, where the specimens picked up were said to have possessed a strong odor of sulphur. This induced young Scriven, who had never before heard of meteoric falls, at once to examine the fence against which the ball had struck. The fence was eight feet high, and formed of long strips of horizontally disposed boards. It was near the extremity of an uppermost board, that had been detached and bent around so as to present its flat side uppermost, that the body had been seen to impinge. And here it was, that he discovered adhering, a small bristling mass of black fibres. These he detached and carried into the house. As it had rained again during the night, he was led to suppose that the rest of the matter had been washed away. He searched the ground among the dead grass, but not until after the second night, when much more rain had fallen. He could find no more of the same material, though he gathered up numerous small fragments, which proved to be ordinary charcoal.

Mr. Scriven (the father) was so much struck with the appearance of the black fibres, together with the circumstances under which they had been found, that he requested his son to call on Dr. Wm. Pettigrew, the family physician, and describe to him what had happened. Two days however elapsed, before Dr. Pettigrew heard of the case. He immediately repaired to the house, where he was informed of the particulars as above described, and shown a mere pinch of the matter that had been detached from the fence,—the principal portion of it having unfortunately been given to a young man of the neighborhood, an engineer at the depot of the Northwestern railroad, who wished to exhibit it to his friends.

Dr. Pettigrew immediately called to acquaint me of the case; but not finding me at home, we did not meet until the forenoon of the 20th, when he presented me the specimen gathered by Scriven, and took me to the spot.

I heard the statements repeated from the different members of the family, corroborative of those above presented, and examined the place upon the board, from whence the fibres had been gathered. It presented no discoloration or appearance of having been heated or charred, though for many inches on either side, it was slightly blackened in spots. This perhaps was not strange, as heavy rains had fallen since the occurrence; and it might fairly be presumed, that all foreign matter would have been effectually detached. I examined the grass and soil on both sides of the fence, without finding anything beyond little fragments of charcoal, which are common enough in most places about the

premises of houses. We then took pains to find the individual to whom had been given the principal portion of the fibrous matter obtained from the fence; but had the mortification to discover, that having worn it in a paper wrapper for several days in his vest pocket, he had finally mislaid or lost it. Thus little more than a microscopically visible specimen of the shooting star remained for study and examination. Its entire weight is probably less than one-tenth of a grain. When viewed by a single pocket-lens, it seems to be a confused aggregate of short clippings of the finest black hair, varying in length from one-tenth to one-third of an inch. Each portion is straight or only slightly curved. Except in color, they remind one most of that variety of pumice stone from the Sandwich Islands, known as volcanic hair, or as "*Pele's hair.*" They do not seem very prone to break in handling, and appear slightly elastic.

They have been examined under compound microscopes of high power by several persons accustomed to the use of this instrument; but hitherto no one has ventured to suggest a relationship in their properties, to any known form of organic or inorganic matter. The following description is from a note, handed to me by my friend, Dr. F. W. Porcher of Charleston. "Black elongated bodies, perfectly opaque, round and solid; amorphous, not properly smooth, surfaces often furnished with warty dots or projections; rather glossy."

In fig. 1, I have enlarged Dr. Porcher's drawings of a few of the forms about four times, as they presented themselves to him, through a one-third inch object-glass. A few of the bodies are subspinose, and one or two decidedly bifurcate; others are cancellated, and seem capable of separation into smaller fibres. The surfaces are not always perfectly round.

I could spare only a few of them for a chemical trial. These were introduced into a small glass test-tube (previously well dried), and heated by contact of the flame of the blowpipe. They suddenly glowed with a brilliant light, at the same time emitting an odor most nearly resembling the bituminous. A distinct greyish skeleton of each fibre was left adhering to the glass. Barytic water being thrown into the tube was instantly rendered milky, thereby proving the existence of carbonic acid; and the subsequent addition of hydrochloric acid slowly caused the separation of the skeletons from the glass, which led me to infer the presence of silica as a part of the earthy residuum. The little bodies however were not annihilated by the process; but greatly to my surprise were easily seen, by the aid of a single lens, still floating through the clear liquid, preserving in a great measure their original form, with the exception only, of being rendered here and there transparent, as if about one-half of the black

matter had been eaten out and dissolved, leaving the remainder sufficiently connected to maintain the original figure of the body. This honeycomb appearance is also represented in three of the drawings (fig. 2) made by Dr. Porcher.

1.

This is all that I have been able to ascertain concerning the origin, structure, and chemical composition of these singular bodies. They appear to be inorganic, though composed in part of carbon. A large proportion of earthy matter also, enters into their composition.

It will be remembered perhaps, in this connexion, that Berzelius detected what appeared to him to be an organic residuum (resembling burnt hay) in the French meteoric stone of Alais that fell March 15, 1806; and bearing more distinctly still upon our subject, are the highly interesting results recently obtained by Prof. Wöhler on the unknown substance of an organic nature (resinous) in the meteoric stone of Kaba, Hungary, that fell April 15, 1857, and those again arrived at by Prof. E. P. Harris in the Göttingen laboratory concerning the carbonaceous matter in the stone that fell Oct. 13, 1838, at Cape of Good Hope, — a meteorite originally described by Sir John Herschell and Prof. Faraday. Prof. Harris states in his valuable thesis on meteorites (Göttingen, 1859), that he finds a quarter per cent of bituminous matter in the Cape stone, which is soluble both in alcohol and ether, and fusible in a glass tube over a spirit lamp. It finally burns with a bituminous odor and the deposition of carbon.

2.

Is the matter of the Charleston shooting-star analogous to that of the Alais and the Cape meteoric stones? And if so, may the more complete combustion of its carbonaceous ingredient have been prevented by the humid state of the atmosphere at the time of its fall? These are questions that naturally suggest themselves, but to which we are not in a condition to return satisfactory replies at present.*

It is reasonable perhaps to suppose that many aggregates of meteoric matter, such for example as those made up wholly of one or more of the following meteoric elements: carbon, phosphorus and sulphur would, owing to their easy combustibility burn out, even in the upper regions of the atmosphere, and being resolved into gaseous compounds, fail of transmitting to the earth's surface any material proof of their existence. Others again may not be recognized at the surface of the earth, owing to the dispersion of their oxyds in the condition of an impalpable dust, or in solution in water. But however this may be, the facts seem thickening about us of the occasional arrival out of the air, of anomalous earthy bodies, whose descent is unaccompanied by the explosions belonging to the true meteorites, and the precipitated matter is uncharacterized also, by the possession of a thin, well fused coating or crust.

The study of these pseudo or doubtful meteorites, as they have been called, is worthy of a much closer attention than has hitherto been devoted to them; and it is to be regretted, that they continue still to be treated much as the true stones and iron masses were, prior to the time of Chaldni and Howard. Their study seems to be regarded as a field, exterior to the domain of legitimate science,—a region for the reception of all that is vague and contradictory. Much time and labor will no doubt be requisite to disentangle what is really entitled to scientific regard; but this desirable result will be yet longer postponed, if naturalists continue to dismiss as unworthy of investigation, every reported meteoric fall that is unattended with the stereotyped accompaniments, of the descent of the black encrusted stone and iron-mass, the frequency of whose arrival has now so multiplied, as to make the recital of their apparition almost monotonous.

Without here referring to many of the doubtful meteorites, of which I have from time to time given notices, I will venture to call attention to a few other instances, of which no scientific mention has yet been made,—not claiming for them however,

* As having possibly a close connexion with the subject in hand, may be mentioned, two instances recorded in Chladni's list of ancient meteorites. The first of these refers to the fall at Rockhausen near Erfort, July 5, 1582,? during a frightful tempest, of a large quantity of a fibrous substance, similar to hair. The second occurred March 25, 1665? at a place near Lancha, not far from Naumburg, in which case, the matter that fell was likewise fibrous, and resembled a bluish silk. It was also abundant.

any other character than that of mere hints, intended to awaken regard to a fuller investigation of analogous cases, as they may from time to time present themselves.

It was not far from the month of August, 1834, that the newspapers announced the fall of a blazing meteor in the night, in the town of Norwich, Conn. Its descent was unaccompanied by any report, and the mass of matter in its course, came near falling upon the roof of a house, missing it only by the space of about two feet, and nearly burying itself in the rather soft earth of the door-yard. The phenomenon occasioned much fright to the occupants of the house, who were only females. It was seen however, by others. The mass of matter occupying the cavity was of a flattened form, and nearly as large over as a man's head. It had the appearance (in the words of a neighbor who saw it and who described it to me a few weeks after) of a mass of earth, stuck together by the infiltration of tarry matter. And such he took it to be, supposing that some mischievous persons had prepared a fire-ball, and projected it on fire into the air, with the intention of alarming the inmates of the house. I was shown the cavity said to have been produced by the ball; but the specimen had been given to a medical student, who had sent it to his preceptor, residing in or near Albany, N. Y. The circumstances were on the whole so discouraging to the idea of its being a genuine meteorite, that I gave the subject no further consideration. It may not be too late, to recover further information respecting its character.

On the evening of the 23d of April, 1855, at Ochtertyre House, Crieff, in Perthshire (Scotland), a young woman saw from the third story, a shooting star or meteorite, falling with a brilliant light. It struck the gravel walk near to the house. She instantly called two other females, "who saw as it were, a bright object on the gravel, like the sun shining on a large diamond." Two of them ran out of the house and round a court-yard to the spot, taking matches and a candle with them. As soon as they got to the spot, one of them picked up two cindery fragments, which were too hot to hold, and which emitted a strong sulphurous smell. The other felt something hot under her foot, which she also picked up. It had a similar character with the other fragments. At first it was believed that these masses had actually fallen from the heavens; but a closer investigation into their character left little doubt that they were merely fragments of ordinary cinder, derived from a neighboring furnace, situated upon a stream, whence gravel had been obtained for dressing the walks. Being at Sheffield in England, when the subject was undergoing investigation, I was favored by Sir William Keith Murray, at whose residence the occurrence took place, with an inspection of one of the specimens, and was satisfied that a correct general view had been taken of their character. Nevertheless, as

the confidence of the gentleman referred to, was full and entire in the integrity of the witnesses of the phenomenon, it would seem to be an instance, in which the sulphurous matter of a shooting star was not completely consumed before reaching the ground, and that much of the residuum suffered oxydation after it struck upon the cinder of the walk.*

My meteoric cabinet has contained for many years, a few grains of a mixture of carbonaceous and earthy matter in a pulverulent state, sent to me in 1845 by Mr. Black, of Elizabethtown, Essex county, N. Y., (then a member of the Legislature of New York), as having fallen in his wood-yard during the winter of 1844 and 1845.

As an appendix to this unsatisfactory list of supposed meteorites may be added a statement concerning a specimen, the half of which is in my possession, so puzzling in its properties as to leave me in great doubt, whether to arrange it among terrestrial or celestial productions. Its history is briefly as follows. It was brought to Dr. Gibbs of Columbia, S. C., by a poor woman resident in the vicinity, under the impression I believe, of its having fallen from the skies; and as such, was presented to me by Dr. Gibbs. Its size is about that of an ordinary fig, which fruit in a compressed state, it somewhat resembles in figure. Its surface was nearly black, rough and without a glaze. It seemed hollow, and reminded me of an impure, brown iron-stone œtite. On breaking it open, it presented an irregularly shaped cavity, holding nearly a thimble full of silicious sand, and had upon its interior walls, little pellets (half the size of a mustard seed) of pure lead, almost exactly resembling those found in the Hemalga (Chili) meteoric iron.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On Ammonia-Chromium bases.*—FRÉMY has discovered a class of ammonia-chromium bases, analogous to those formed by cobalt, iridium and rhodium. The author, who appears to be ignorant of what has already been written upon the subject, distinguishes two isomeric modifications of the sesquioxyd of chromium, one of which he terms "chromoxyd" and the other "metachromoxyd," the latter being the soluble and the former the insoluble modification. When metachromoxyd is treated with ammonia in the presence of a salt of ammonium it dissolves completely, forming compounds which are distinguished by their beautiful violet rose red color: alcohol precipitates from these solutions beautiful violet substances, which the author terms amido-chrom compounds, but the analyses of which are not given. These substances are easily decom-

* It was found by Dr. Heddle of Edinburg, that the cinder still retains distinct traces of sulphur.

posed; among the products of their decomposition the author has discovered an ammonia-chromium base which has the formula $Cr_2O_3 . 4NH_3$. The constitution of the salts of this base may be represented by the general expression $Cr_2O_3 . 4NH_3 + 3A$, in which A represents one equivalent of acid. The solutions are almost pure rose-red—the chlorid, which the author considers as a hydrochlorate, has the formula $Co_2O_3 . 4NH_3 + 3HCl$. The salt crystallizes from an acid solution in the form of beautiful regular octahedrons; it forms crystallizable double salts with the chlorids of platinum and mercury. In addition, the author has discovered two other salts, which appear to contain different bases.—*Comptes Rendus*, xlvii, 883.

2. *On the preparation of Alizarin.*—Vilmorin has given a simple method of preparing alizarin from commercial garancin. Garancin is to be treated two or three times with a solution of pure ammonia alum in water, containing half as much alum as the garancin employed. The liquid after filtering has a very beautiful scarlet orange color. It is to be evaporated with repeated stirring, so that the alum may form only small crystals which are encrusted with amorphous alizarin. This product is to be dried, then rubbed to powder, and treated in a water bath with boiling bisulphid of carbon, which dissolves only the alizarin and leaves the alum which may then be employed again. The solution of alizarin in bisulphid of carbon has a brilliant gold yellow color; it is to be filtered and on cooling yields groups of crystalline needles, with a silky lustre. In place of bisulphid of carbon, boiling absolute alcohol may be employed.—*Chemisches Central-Blatt*, No. 24, 1859.

3. *On Wolfram-Steel.*—F. Mayr has prepared an alloy of steel with tungsten which appears to possess very valuable properties. Its tenacity, according to experiments made at the Polytechnic Institute at Vienna, exceeds that of all other varieties of steel hitherto examined, being equal to, on the average, 1159 cwt. to the square inch of section. The method of preparing this steel is not described; the ore of tungsten, as is well known, exists abundantly at Zinnwald in Bohemia and has hitherto found no practical application.—*Chemisches Central Blatt*, No. 25, 1859.

4. *On several new Alcohols.*—Berthelot has shown that cholesterine, Borneo camphor and meconine may be regarded as alcohols, since when subjected to the action of acids, water is eliminated and a class of neutral substances produced analogous to the ethers. The author's method of experimenting consists in enclosing the alcohol and acid together in a sealed tube, and exposing the mixture for eight or ten hours to a temperature of 200°. Under these circumstances combination usually occurs with facility. The compounds of cholesterine with stearic, benzoic, butyric and acetic acids, are solid and crystallizable; more fusible than cholesterine, more or less soluble in ether, very slightly soluble in boiling alcohol. Their physical properties, fusibility, etc., are intermediate between those of the waxes and resins. When treated for a long time with the hydrated alkalies at 100°, these ethers are resolved into cholesterine and acid which remains united with the alkali. The author concludes from his analyses, that the true formula of cholesterine is that of Gerhardt, viz.: $C_{52}H_{44}O_2$. Meconine in combining with acids loses four equivalents of water; the author succeeded in preparing a benzoate and stearate. He farther points out the relations which exist between meco-

nine, $C_{20}H_{10}O_3$, and the products of its oxydation, viz.: opianic and hemipinic acids; $C_{20}H_{10}O_{10}$ and $C_{20}H_{10}O_{12}$. These relations are the same as those between olefiant gas C_4H_4, aldehyd $C_4H_4O_2$, and acetic acid $C_4H_4O_4$.

Orcine, $C_{14}H_8O_4$, also appears to enter into combination with acids, though the quantity of matter at the author's disposal did not permit him to determine this with absolute certainty.

Borneo camphor $C_{20}H_{18}O_2$ plays the part of an alcohol, which the author proposes to call camphol. Camphol combines easily with muriatic acid at the temperature of 100°, and with the organic acids at 200°. The ethers are neutral, colorless, more fusible than camphol, sometimes liquid and sometimes crystallizable. In their formation, two equivalents of water are eliminated. The chlorhydric ether of this alcohol closely resembles the compound formed by the action of muriatic acid gas upon oil of turpentine, and commonly known under the name of artificial camphor, the only difference between them consisting in their power of rotating polarized light. The author did not however succeed in obtaining camphol by heating artificial camphor with an alcoholic solution of soda. Ordinary camphor may be regarded as the aldehyd of camphol, which latter can be obtained from it by boiling with an alcoholic solution of caustic potash. A peculiar acid is at the same time produced which has probably the formula $C_{20}H_{16}O_4$ and which the author calls camphic acid. Camphol is the type of a series of alcohols, represented by the formula $C_{2n}H_{2n}-_2O_2$.—*Ann. de Chimie et de Physique*, lvi, 51.

5. *On a new Product of the decomposition of Trinitrophenic Acid.*—By the action of cyanid of potassium upon picric acid, Hlasiwetz has prepared a new acid which he terms isopurpuric acid, and which is isomeric with the purpuric acid obtained from uric acid. Two parts of cyanid of potassium are to be dissolved in four parts of water, the solution warmed to about 60° and the hot solution of one part of picric acid in nine parts of water added with constant stirring. On cooling, the solution becomes a soft mass of crystals, which after purification are brown red and scaly, and reflect a green light. These crystals are the potash salt of the new acid; they are slightly soluble in cold, but perfectly soluble in boiling water. The solution has a very intense and pure purple color. The salt explodes on heating, and gives precipitates with several metallic solutions. The formation of this substance may be expressed by the equation

$$C_{12}H_3N_3O_{14}+3(C_2NH)+2HO=C_{16}H_5N_5O_{12}+C_2O_4+NH_3.$$

The author has analyzed and described various salts of the new acid and has compared its physical and chemical properties with those of purpuric acid. According to Grailich's observations, isopurpurate of ammonia is both crystallographically and optically similar to murexid. In fact, it is difficult to decide from the author's memoir, upon what grounds a distinction is to be made between purpuric and isopurpuric acids.—*Ann. der Chemie und Pharm.*, cx, 289. W. G.

6. *Sir H. Davy's Discovery of the Alkaline Metals: correction of a prevalent historical error in relation thereto.*—It has frequently been a matter of regret that in the history of the world the progress of science has held a secondary place to that of bloodshed, tyranny and political in-

trigue. The most trifling acts of kings and generals are recorded and commented upon, and any misstatement in regard to them is soon detected and pointed out to the confusion of the erring historian. But it is often found to be otherwise in the history of those things which have most benefitted mankind. The most reckless statements in regard to these pass unchallenged as unworthy of notice or rectification, and are disseminated by each succeeding writer until the authority in favor of the error preponderates (numerically at least) over that in favor of the truth.

A striking instance of this occurs in relation to Sir H. Davy's great discovery. Seeing it stated in Lardner's Hand-book of Electricity that it was with the great battery of two thousand pairs of plates belonging to the Royal Institution that Davy succeeded in decomposing the alkalies and resolving them into metals and oxygen, and knowing that such was not the fact, it occurred to me to look up the statements of other physicists upon this point. I was aware that Pouillet in his "Traité de Physique" (from which Lardner has largely copied) makes a similar statement; but this I was prepared to expect in the works of an associate of those savans who alleged to Napoleon that they were prevented from anticipating Davy's discovery only by the want of an apparatus of sufficient power. But that an English philosopher should fall into such a mistake somewhat surprised me, and I was still more astonished to find that British authors, long before the time of Lardner and Pouillet, had given currency to the same misstatement. Indeed so powerful was the array of testimony in favor of this error (at least so far as the *number* of authors went) that I was at one time tempted to doubt my own clear recollection of Davy's own record, and it was only by again turning to it that I could reassure myself. There however he mentions distinctly that the battery used consisted of only one hundred pairs of six inch plates; and still further, in a note to the Bakerian lecture for 1808, he states that many have been deterred from repeating these experiments, supposing that a battery of enormous power is required, and corrects this false impression by stating that one to two hundred pairs of plates in moderate action is amply sufficient. Seeing then that Davy himself deemed this error of sufficient importance to merit correction, perhaps I may be excused for calling attention to the propagation of it by so many respectable authors.

Turner's Chemistry is the earliest work in which I have found this error. In Murray's system (1819) the facts are minutely and correctly stated, but the power of the battery is not given. But what astonished me most was to find that Leithead, Secretary to the London Electrical Society, in a work published in 1837 ("Electricity—its nature, operation and importance," &c.) and dedicated to no less an electrician than Sir M. Faraday, the friend and pupil of Davy, makes the same erroneous statement in his book, page 183.

From Turner and Pouillet the error has spread to a host of minor authors until our scientific literature has become infected with it to a wide extent. Golding Bird, whose means of obtaining correct information were no doubt ample, seems to have labored under the impression that the discovery was made with the great battery; and even de la Rive in

his recent elaborate work on electricity (tome 1, page 46) falls into the same mistake.* Lardner in his Lectures even goes so far as to make an enthusiastic defense of Davy from the imputation that he owed this accession to his reputation to the fortuitous circumstance of his having access to the large battery of the Royal Institution. But he does not correct the error. A few of our minor authors (Bakewell for instance) seem to have read the Bakerian Lecture for themselves; and a few French authors, as Becquerel and Figuier, have nobly given Davy his due.

The extent to which this error has been copied shows with what servility many of our modern compilers of text-books follow the leadership of any great name, and how necessary it is to look to original authorities where accuracy is of the least importance. The facts to which we have called attention occupy no mean place in the history of chemistry, and as it was in Davy's time so it is now, many have been deterred from repeating these interesting experiments by an apprehension that an apparatus of great power is requisite. Such is however by no means the case. Singer states that a battery of fifty pairs of plates in good action are amply sufficient, and of the modern and improved forms a much smaller number is requisite. J. P.

Rochester, N. Y., July 26th, 1859.

[*Note by the Editors.*—Another remarkable example of the regular propagation of error from hand to hand, extending through a large portion of our scientific literature, is the story usually found in text-books, of the accidental discovery in 1790 of the science of galvanism by the twitching of frogs legs prepared for the repast of Madame Galvani. This fabrication is attributable to Alibert, an Italian writer of no repute. Galvani had for eleven years been engaged in an elaborate research on animal electricity, in which he used frogs legs as sensitive electroscopes. The error has been continued from the want of a careful distinction between the real discoveries of Galvani and of Volta. Galvani was an anatomist and physiologist, and he really discovered the existence of electrical currents in living or recently dead animals, and he justly attributed the convulsions of the frogs legs when made without a metallic arc—by contact of the exterior mucous with the interior nervous surface—as due to a nervous or vital fluid, the *true galvanic fluid*. The importance and even the reality of this discovery of Galvani was hidden by the splendors of Volta's pile, until in 1837, more than fifty years afterwards, Matteucci

* The words of M. De la Rive are—"La pile à auges independentes en verre ou en porcelaine avec couples metalliques mobiles, forme sous laquelle fut construite la pile de deux cents couples de l'Institution Royale de Londres, au moyen de laquelle Davy fit les grandes decouvertes qui out immortalisé sou nom." He here evidently alludes to the great battery of the Institution which consisted of two hundred *instruments*, each containing ten "couples" or pairs of plates, thus making 2000 pairs in all. (Davy, Elements of Chemistry, p. 152.) This battery was first used in May or June, 1810 (Phil. Mag., vol. xxxv, page 463), while the alkalies were decomposed October 19th, 1807. (Life of Davy by Paris, and Journal Royal Institution, vol. i, p. 360.) Another battery of 500 pairs of plates was constructed in May, 1808. But the battery used in the decomposition of the alkalies was constructed in 1803 and was very much worn at the time of Davy's discovery. We can find no record of any battery having been constructed for the Royal Institution which answers the description given by M. De la Rive, but if for "couples" we read "instruments" the description applies exactly to the great battery.

revised Galvani's original and correct opinions. Volta's discovery of the pile he announced in March, 1800, to Sir Joseph Banks, although he conceived his "contact theory" in 1796. Galvani died, however, in 1798 (Dec. 4), before the discovery of the pile, and yet we constantly read of the galvanic battery and the frogs legs as related facts of his discovery. It is worse than an anachronism to say that Galvani divided with Volta the honor of discovery of the pile, since he died before it was discovered. Prof. James D. Forbes, in his sketch of the progress of mathematical and physical science in the Encyc. Brit., (8th ed.) has given the best account of the labors of Galvani and Volta to be found in English. In that essay Prof. Forbes says (§ 765) respecting the discoveries of Davy, "Potassium was discovered in the laboratory of the Royal Institution on the 6th of October, (Oct. 19th?) 1807, and sodium a few days later. The battery used contained 250 pairs of plates of 6 and 4 inches square." Davy in reality employed, it is probable, two batteries; one of *one hundred* pairs of 6 inch plates, and another of *one hundred and fifty* pairs of 4 inch plates.]

7. *On the Electrolysis of Sulphuric acid;* by Dr. ANTON GENTHER. (Liebig and Kopp's Annal., Feb. 1857).—The following experiments were undertaken for the purpose of deciding the question whether an electrolyte of different constitution than the simple binary relation of atom for atom of each element is capable of decomposition by the current. Previous experiments with chromic acid, chlorid of iron and chromate of potash, had well nigh decided the question in the affirmative, but the attempt to decompose sulphuric acid made with eight cells of Bunsen's battery by Prof. Magnus, failed to confirm this view of it. The failure Dr. Genther attributed to the limited force of the current, and accordingly renewed the experiment with fourteen of Bunsen's cells. The anhydrous acid still resisted, and even when the platina poles were approached so close as to ensure the direct transmission of the current, it only gave signs of a rapid bubbling movement. The anhydrous acid was next mixed with different quantities of acid of the constitution SO_3+HO, and the mixture exposed to the action of the same battery in a U-form tube. The proportions first tried were four of the anhydrous to one part of the other acid. This mixture yields a solution crystallizing at 68° F. It is therefore necessary to apply a higher temperature which is invariably obtained by the continued action of the current. The conducting power of this solution is so low as to allow only a very small distance to intervene between the poles. Soon after the action commences oxygen is liberated at the positive pole, whilst not a gas bubble appears at the negative. The solution however being of a brownish yellow cast, becomes colorless in the arm of the tube containing the positive electrode, the color being entirely confined to the other arm. The action being allowed to continue, blue streaks slowly make their appearance on the surface of the liquid at the negative pole, which although multiplied with the duration of the current, are yet very sparingly developed.

In a second mixture the proportions were three parts of the anhydrous acid to one of the acid SO_3+HO. This gives a solution of better con-

ducting power. As in the former experiment oxygen appears at the + pole, but much more copiously; and at the − pole a slight escape of gas bubbles is perceptible, whilst the blue streaks present themselves in greater quantity, coloring the liquid contained in the negative arm of the tube. The odor of sulphurous acid is also distinctly perceptible. With the continuance of the action the temperature rapidly rises, the escape of gas at the − pole is more abundant, sulphurous acid is formed, but the blue streaks diminish when the tube is immersed in water gradually heated, the blue streaks disappear altogether at 140° F., and a more copious formation of sulphurous acid sets in. As the tube containing the electrolyte is gradually cooled the color reappears.

This whole process is effected much more rapidly when the mixture is in the proportion of two parts of the anhydrous to one of SO_3+HO, or of equal parts of both, the temperature being kept at 32° F. The blue color at the − pole clearly proves that sulphur is liberated there, the solution resembling that obtained by dissolving sulphur in anhydrous sulphuric acid. Of this fact, the temperature at which decomposition takes place, and the formation of SO_2, furnish sufficient testimony independent of the color produced.

The development of sulphurous acid seems to be occasioned by the rise of temperature produced in the solution by the action of the current. Nor is it confined to the negative arm of the tube; circumstances which indicate that it is a secondary product.

In regard to the sulphur which has been observed as the negative pole, there are only two ways of accounting for its presence. It is either the result of direct decomposition by the current, or of the reducing action of the liberated hydrogen.

The combination SO_3 with HO, according to Faraday, is decomposed into sulphur and hydrogen at one electrode and oxygen at the other. The same combination subjected to the action of the battery by Genther gave at first only H and O at their proper poles; sulphur was liberated only when the temperature of the electrolyte was considerably raised by the action of the current. When the tube was placed in water kept at 32° F., the liberation of oxygen and hydrogen was of longer duration before free sulphur appeared. The temperature of the electrolyte was found to rise almost instantaneously with the removal of the tube from the water. This would seem to indicate that by keeping the electrolyte at 32°, the liberation of sulphur would be prevented, which shows the great influence temperature has on the product of the decomposition. It was further observed that the odor of sulphurous acid accompanied the liberation of sulphur, owing probably to the action of S on the warm sulphuric acid. If we assume that in this process the liberation of the sulphur is due to the reducing action of H, then it consistently follows, that the H endowed with so strong an affinity, must unite with the sulphur it meets at the moment of separation, and form sulphuretted hydrogen. Not a trace of this gas has however been yet detected. Furthermore if the hydrogen could exert this reducing action, it would at most be but the reducing of SO_3 to SO_2. With such proofs drawn from experiment we must assume the direct decomposition by the current of sulphuric acid into S, which appears at the − pole, and oxygen at the + pole. It

depends on the concentration of the acid whether the extra decomposition of water accompanies the foregoing products.

That an electrolyte differing from the simply binary constitution is capable of direct decomposition by the current is thus shown in the case of SO_3, and even with less room for doubt in the case of anhydrous chromic acid, and chromate of potash, as the researches of Prof. Magnus prove.

II. GEOLOGY.

1. *Teeth and Bones of Elephas primogenius, lately found near the western fork of White River, in Monroe County, Indiana;* communicated by Prof. T. A. Wylie.—On Friday, July 23d, in company with Prof. Cole, I visited the place where these bones were found. It is situated on the farm of Jefferson Wampler, about a mile southeast of the town of Gosport. On the 6th of June last, one of the young men, in whose possession the bones now are, found one of the teeth, which had been washed out from the bank by a heavy rain. This led to a further exploration, and the discovery of the tusks and teeth and several fragments of the skeleton. The bank into which they dug is a stiff plastic bluish clay. The bones were found at the depth of eight or nine feet, in a bed of sand underlying the clay, all in confusion as if they had drifted there, and had afterward been covered with the clay. The sand probably rests on sandstone (Carboniferous) which forms the bottom of the brook not many yards distant. Several of the larger bones were so far decayed that they crumbled on attempting to take them out.

The tusks are much broken and require to be bound with cord to keep the pieces together. Some portions of the ivory are so soft that they yield to the knife like chalk. Toward the point of one of the tusks the substance is much harder. The intelligent young men, W. M. Craven and J. H. Richardson, by whom the discovery of these remains was made, deserve credit for the care they have taken in disinterring and preserving them.

The bones consist of two tusks, four molar teeth, and several fragments, viz., a piece of a rib, an end of the radius (?) much worn, measuring about seven inches across its concave surface, and a few spongy portions of the larger bones.

One of the tusks measures on the outside of the curvature eight feet, a foot or more has been lost from the root, the cavity of which is filled with sand. The diameter of the root end is eight inches, the tusk varies very little in the size of the cross section till near the point. The projection of the axis of the tusk on a plane is nearly a semicircle of a radius of 30 inches. The deviation of the axis from the plane is but slight, though this could not be determined accurately on account of the transverse cracks. The other tusk has lost a portion of the pointed extremity, judging from the appearance of the fracture, this might have been lost before the death of the animal. It measures five feet in length, and in diameter is the same as the other. The weight of the larger tusk is 166 pounds.

There are four molar teeth, two larger and two smaller. The largest measures, in the longer diagonal from crown to base, eleven inches; ver-

tically, eight inches. Across the grinding surface, four inches. The smaller molars are about eight inches, and five inches in the same directions. The length of the grinding surface on one of the smaller molars is six inches. The grinding surfaces of these teeth are nearly flat. The plates of enamel very perfectly preserved. In the larger of the teeth twenty of these double plates were counted; in the smaller, fourteen. The distance between the plates, and the interval between the pairs, is about one-fourth of an inch. They resemble some drawings I have seen of modern elephant's teeth, though the *flattened cylinders* of enamel in the case of the fossil are much more compressed and closer together than those of the recent teeth. The columnar structure, if it might be so called, was very evident in all, particularly in the smaller, where the cylindrical columns of enamel were distinct, and where also the gradual coalescing of three of these into one, could be distinctly perceived.

Indiana State University, Bloomington, August 1st, 1859.

2. *Eruption of Mauna Loa, Sandwich Islands;* (latest information in a letter to J. D. DANA from Prof. R. C. HASKELL, Oahu College, dated Kona, Hawaii, June 22d, 1859).—I have just returned from a second visit to the scene of the lava-flood on Mauna Loa. There is one fact which I observed, that I desire to communicate to you. The real source of the flow is about four miles above the two craters, which in February seemed to be the source. From this point down to the two craters, a crack in the mountain can be traced nearly all the way. At first it is no more than two inches in width, but gradually increases to about two feet. At the present time heat can be perceived in the crack within a few feet of the highest point. But little lava has issued from this crack above the two craters. During the first quarter of a mile, lava has oozed out in different places a few rods apart, to the amount of three or four cubic feet. Below this point there is a stream, now cold of course, a few rods in width. In this flow therefore there is no doubt that there is a continuous crack in the side of the mountain for four miles. How much farther this crack extends down the mountain cannot be ascertained, now at least, for the craters are still sending forth immense columns of sulphurous vapors, and the stream of lava is still flowing below them. This stream however is much smaller than it was in February, and is entirely subterranean for the first twenty-five or thirty miles, except that there are a few holes where the running lava can be seen. In some instances this stream is as much as forty feet below the surface. During this trip I went to the top of Mauna Loa. There is no perceptible action in the crater of Mokuaweoweo. The source of the present flow is probably about 11,000 feet above the level of the sea.

3. *Observations on the Ossiferous Caves near Palermo;* by Dr. FALCONER, (Proc. Geol. Soc. London, Athenæum, July 16, 1859, p. 86).—Dr. Falconer, in the first place, adverted to his previous communication, read on the 4th of May last, before his collections had arrived in England. In the present paper he submitted, with more detailed explanations, the materials on which his first statements were founded. Dr. Falconer then described the physical geography of that portion of the northern coast of Sicily in which the ossiferous caves abound, namely, between Termini on the east, and Trapani on the west. Along the Bay of Palermo, and

again at Carini, the hippurite limestone presents inland vertical cliffs, from the base of which stretch slightly inclined plains of pliocene deposits, usually about one and a half miles broad, towards the sea. The majority of fossil shells in these tertiary beds belong to recent species. At the base of those inland cliffs, but sometimes 50 feet above the level of the plain, and upwards of 200 feet above the sea, the ossiferous caves occur. One of the best known of these is the Grotto di Santo Ciro, in the Monte Griffone, about two miles from Palermo. This cave has been often described. Like many others it contains a thick mass of bone-breccia on its floor, extending also beyond its mouth and overlying the pliocene beds outside, where great blocks of limestone are mixed with the superficial soil. The bones from this cave had long been known, and were formerly thought to be those of giants. Some years since bones were here excavated for exportation; and M. Christol at Marseilles was surprised to recognize the vast majority of remains of two species of *Hippopotami* amongst bones brought there, and counted about 300 astragali. Besides the *Hippopotamus*, remains of *Elephas* also occur. Prof. Ferrara suggested that the latter were due to Carthaginian elephants, and the former to the animals imported by the Saracens for sport.

The government of Palermo having ordered a correct survey of this cave and its contents, it was found that beneath the bone-breccia was a marine bed with shells, and continuous with the external tertiary deposits. The wall of the cave to the height of eight feet from the floor had been thickly bored by *Pholades;* for the space of ten feet higher the side was smooth; and still higher up it was cancellar or eroded. Above the breccia were blocks of limestone, covered by earthy soil, in which bones of *Hippopotami*, with a few of those of *Bos* and *Cervus*, light and fragile, not fossilized as in the breccia, occurred plentifully. In his late visit to the San Ciro Cave, Dr. Falconer collected (besides the *Hippopotamus*) remains of *Elephas antipuus*, *Bos*, *Cervus*, *Sus*, *Ursus*, *Canis*, and a large *Felis*, some of which indicated a pliocene age.

Another cave, the Grotto di Maccagnone, about twenty-four miles to the west of Palermo, was lately the especial subject of the author's research, whose attention was directed to it by J. Morrison, Esq. In its form it differs from that of San Ciro, being much wider. Its sides show no Pholad markings nor polished surfaces, as far as they are yet bared. It has a reddish or ochreous stalagmitic crust covering the interior. It agrees with the San Ciro Cave in its situation at nearly the same elevation above the sea and above the tertiary plain; and in its enormous mass of bone-breccia and great accumulation of limestone boulders covered by the humantile soil with loose bones. The floor had already been dug over for bones. Beneath this (as shown by the section which Dr. Falconer made at the mouth of the cave) was the usual ochreous loamy earth (called "cave earth"), with huge blocks of blue limestone, which impeded the operations of search. Then a reddish-grey, mottled, spongy loam, cemented by stalagmite, occurring in thick patches, and called "cinere impastate" by the peasants. This covers bone-breccia resembling that of San Ciro, and, like it, is full of bones of *Hippopotami*. The remains of a large *Felis*, two extinct species of deer, and of *Elephas antiquus* were met with also. The last is characteristic of the other pliocene caves of

Europe. Coprolites of a large *Hyæna* occur in ochreous loam; and especially in a recess on the face of the cliff near the cave's mouth. A patch of the "cinere impastate" was found under the superficial earthy floor of the cave at one spot near the inner wall.

The author next described some remarkable conditions in the roof of the cave. About half way in from the mouth, and at ten feet above the floor, a large mass of breccia was observed, denuded partly of the stalagmitic covering, and composed of a reddish-grey argillaceous matrix, cemented by a calcareous paste, containing fragments of limestone, entire land shells of large size finely preserved, splinters of bone, teeth of ruminants and of the genus *Equus*, together with comminuted fragments of shells, bits of carbon, specks of argillaceous matter resembling burnt clay, together with fragments of shaped silicious objects of different tints, varying from the milky or smoky color of chalcedony to that of jaspery hornstone. This brecciated matrix was firmly cemented to the roof, and for the most part covered over with a coat of stalagmite. In the S. S. E. expansion of the cavern near the smaller aperture, a considerable quantity of coprolites of *Hyæna* was found similarly situated in an ochreous calcareous matrix, adhering to the roof, mingled with some bits of carbon, but without shells or bone-splinters. On the back part of the cavern, where the roof shelves towards the floor, thick masses of reddish calcareous matrix were found attached to the roof, and completely covered over by a crust of ochreous stalagmite. It contained numerous fragments of the siliceous objects, mixed with bone-splinters and bits of carbon. In fact, all round the cavern, wherever the stalagmitic crust on the roof was broken through, more or less the same appearances were presented. In some parts the matrix closely resembled the characters of the "cinere impastate," with a large admixture of calcareous paste. With regard to the fragments of the siliceous objects, the great majority of them present definite forms, namely, long, narrow, and thin; having invariably a smooth conchoidal surface below, and above, a longitudinal ridge bevelled off right and left, or a concave facet replacing the ridge; in the latter case presenting three facets on the upper side. The author is of opinion that they closely resemble, in every detail of form, obsidian knives from Mexico, and flint knives from Stonehenge, Arabia, and elsewhere, and that they appear to have been formed by the dislamination, as films, of the long angles of prismatic blocks of stone. These fragments occur intimately intermixed with the bone-splinters, shells, &c., in the roof-breccia, in very considerable abundance; amorphous fragments of flint are comparatively rare, and no pebbles or blocks occur either within or without the cave. But similar reddish flint or chert is found in the hippurite limestone near Termini.

In regard to the theory of the various conditions observed in the Maccagnone Cave, the author considers that it has undergone several changes of level, and that the accumulation of bone-breccia below and outside is referrable to a period when the cave was scarcely above the level of the sea. Dr. Falconer points out the significance of the fact, that although coprolites of *Hyænæ* were so abundant against the roof and outside, none, or but very few, of the bones of Hyænas were observed in the interior. He remarked also on the absence of the remains of small mammalia,

such as Rodents. He inferred that the cave, in its present form, and with its present floor, had not been tenanted by these animals. The vast number of *Hippopotami* implied that the physical condition of the country must have been very different at no very distant geological period from what obtains now. He considered that all deposits *above* the bone-breccia had been accumulated up to the roof by materials washed in from above, through numerous crevices of flues in the limestone, and that the uppermost layer, consisting of the breccia of shells, bone-splinters, siliceous objects, burnt clay, bits of charcoal, and coprolites of *Hyæna*, had been cemented to the roof by stalagmitic infiltration. The entire condition of the large fragile *Helices* proved that the effect had been produced by the tranquil agency of water, as distinct from any tumultuous action. There was nothing to indicate that the different objects in the *roof-breccia* were other than of contemporaneous origin. Subsequently a great physical alteration in the contour, altering the flow of superficial water, and of the subterranean springs, changed all the conditions previously existing, and emptied out the whole of the loose incoherent contents, leaving only the portions agglutinated to the roof. The wreck of these ejecta was visible in the patches of "cinere impastate," containing fossil bones below the mouth of the cavern. That a long period must have operated in the extinction of the Hyæna, Cave-lion, and other fossil species is certain; but no index remains for its measurement.

The author would call the careful attention of cautious geologists to the inferences,—that the Maccagnone Cave was filled up to the roof within the human period, so that a thick layer of bone-splinters, teeth, land-shells, coprolites of *Hyæna*, and human objects was agglutinated to the roof by the infiltration of water holding lime in solution; that subsequently, and within the human period, such a great amount of change took place in the physical configuration of the district as to have caused the cave to be washed out and emptied of its contents, excepting the floor-breccia, and the patches of material cemented to the roof and since coated with additional stalagmite.

4. *On the Bone cave in Devonshire;* by Mr. Prestwich, (Ibid.).—Mr. Prestwich gave in a few words the results of the examination of the bone cave at Brixham in Devonshire. The cave has been traced along three long galleries meeting or intersecting one another at right angles. Numerous bones of *Rhinoceros tichorhinus*, *Bos*, *Equus*, *Cervus tarandus*, *Ursus spelæus*, and *Hyæna* have been found; and several flint-implements have been met with in the cave-earth and gravel beneath. One in particular was met with immediately beneath a fine antler of a Reindeer and a bone of the Cave-bear, which were imbedded in the superficial stalagmite in the middle of the cave.

5. *Observations on a Flint-implement recently discovered in a bed of Gravel at St.-Acheul, near Amiens;* by John Wickham Flower, Esq., (Ibid.)—The gravel capping a slight elevation of the chalk at St.-Acheul is composed of water-worn chalk-flints, and is about ten feet thick; above it is a thin band of sand, surmounted by sandy beds (3 feet 6 in.), and brick-earth (11 feet 9 in.). In this gravel the remains of elephant, horse, and deer have been found, with land and fresh-water shells of recent species. From the gravel Mr. Flower dug out a flint-implement,

shaped like a spear-head, at about eighteen inches from the face of the pit, and sixteen from the surface of the ground. Mr. Flower in this communication pointed out evidences to prove that this and many other similar flint-implements obtained from the same gravel were really the result of human manufacture, at a time previous to the deposition of the gravel in its present place. Mr. Fowler's visit to St.-Acheul was made in company with Messrs. Prestwich, Godwin Austen, and Mylne, with a view to verify the discoveries made respecting the occurrence of flint-implements in the gravel and peat of the Somme Valley by M. Boucher de Perthes, of Amiens.

6. *On Professor C. Piazzi Smyth's supposed proofs of the Submarine Origin of Teneriffe and other Volcanic Cones in the Canaries;* by Sir C. Lyell, F.R.S., D.C.L., etc., (Phil. Mag., July, 1859.)—Since the publication in the Philosophical Transactions of my paper on the Lavas of Mount Etna,* a Report by Prof. Smyth, Her Majesty's Astronomer for Scotland, has been printed by the Admiralty of Great Britain, "On the Teneriffe Astronomical Experiment of 1856," in which a chapter on geology and "volcanic theories" is introduced.

This chapter, which did not form part of the original report as published by the Royal Society in the Philosophical Transactions for 1858, contains a discussion of Von Buch's theory of craters of elevation, together with critical remarks on passages in my writings, and those of Mr. Poulett Scrope. I do not feel myself called upon to reply to any of these comments, as they relate to subjects to which the astronomer for Scotland cannot be expected to have devoted much time or attention; but when facts are cited, respecting Teneriffe and other islands of the Canariad Archipelago, supposed to be conclusive on a controverted question of high theoretical interest, and in a work brought out under the sanction of the Admiralty, I think it right to point out the mistakes into which the author has fallen, and the insufficiency of the evidence on which he relies.

At p. 553 of the new edition of the report above alluded to (dated February, 1859), the following passage occurs:—

"The question of the submarine origin of Teneriffe no longer depends only on the general structure of its lava-beds, or on analogies from the fossiliferous strata of the adjacent islands of Grand Canary and Palma, but has now the additional and most unanswerable argument of fossil shells having lately been discovered about the slopes of the crater."

And again in the same page:—

"The proof of fossil shells, so long demanded, has now been supplied; and with them must be accepted the fact of the slopes on which they rest having been once submarine, though now subaerial. The great crater, then, having incontestably suffered elevation, was that elevation necessarily connected with its present form and character?" &c.

When I first read these passages, I naturally concluded that some new discovery had been made of marine fossils *on the slopes* of the great outer cone of Teneriffe, or "crater," as it is termed in the report above cited; but having never seen or heard of such a fact myself when in the island,

* On the Structure of Lavas which have consolidated on steep slopes; with Remarks on the Mode of origin of Mount Etna, and on the Theory of Craters of Elevation, by Sir Charles Lyell, Phil. Trans. part 2, 1858, p. 703.

I wrote to Prof. Smyth to know where and at what height above the sea, and under what geological circumstances, he or his informants had detected these shells. In reply he could give me no information on any one of these three heads, "he had merely given the statement on report, and not from his own observations." It appears, then, that he had simply learnt that marine fossil shells had been met with somewhere in the island of Teneriffe, a fact well known before his visit in 1856, and before Mr. Hartung and I were there in 1854. These shells, however, did not occur "on the slopes of the crater," but in the suburbs of Santa Cruz, along the shore to the northeast of the town, a part of the island which is geographically and geologically independent, not only of the Peak, which is more than twenty miles distant, but also of that volcanic chain which extends many miles from the flanks of the great cone, trending in a northeasterly direction. The separation of the Santa Cruz rocks from the chain to which the Peak belongs, will be understood by a glance at the maps of Von Buch and Captain Vidal, and by reference to the view of Santa Cruz which Vidal has given in the margin of his map. The tufaceous breccias and sandstones containing marine shells near Santa Cruz do not conform "to the slope" of any crater or cone. So far as they can be seen, they appear to be nearly horizontal, and occur only at slight elevations above the level of the sea. We were told that the same remark holds good in reference to certain other deposits containing shells, which we did not examine, in the northeastern extremity of the island, still further from the Peak.

In the first of the passages above cited, Prof. Smyth has alluded to fossiliferous strata in the islands of Grand Canary and Palma. In regard to Palma, I may mention that Mr. Hartung and I, when we were there in 1854, searched in vain for fossils; no travellers had then found any; and our correspondents in the Canaries have still no knowledge of any having been obtained in that member of the Archipelago.

Lastly, as to the Grand Canary, Von Buch was, I believe, the first to call attention to the existence of marine shells in that island, where Mr. Hartung and I collected them in abundance in 1854, and ascertained that they are imbedded in nearly horizontal strata continuous over a large area, where they form an elevated platform about four hundred feet high, near the town of Las Palmas, a platform terminating abruptly in a range of cliffs near the sea, facing the northeast. These upraised sedimentary strata, with some intercalated basaltic beds, are far removed from the slopes of the great dome-shaped volcanic mass, which forms the central nucleus of the Grand Canary; and if they have any bearing on the question of "Craters of Elevation," they certainly do not corroborate that hypothesis, but, on the contrary are directly opposed to it; for though they have been upheaved in a district where intermittent volcanic action has never ceased, they do not dip away in all directions from a central axis, nor have they assumed a conical or dome-like form.

7. *The Old Glaciers of Switzerland and North Wales;* by Prof. A. C. Ramsay, F.R.S and G.S. London: Spottiswoode & Co. 1859. 8vo, pp. 69, with a map and 14 woodcuts.—This charming essay recalls in vivid coloring the reality of that icy episode in the history of Wales, of which every geological observer has seen there such salient proofs since

Agassiz and Forbes first taught us to open our eyes to the truth on this subject. Those who have not visited the classic scenes of Wales will find the excellent woodcuts of this essay quite a valuable substitute for personal observation.

III. BOTANY.

1. *Eulogy on Robert Brown;* by Dr. Von Martius (translated from the German by Prof. Henfrey, and published in the Annals and Magazine of Natural History for May, 1859).—An eulogy upon "the greatest '*Pflanzenkenner*,' the world has yet produced," pronounced by one of his most distinguished survivors and intimate friends. One so learned, so genial, and so philosophical as Von Martius, cannot fail to interest and instruct, although somewhat of the glow and animation which we expect in the original may be lost in the translation. We are pleased to learn the curious fact, that a humble but peculiar North American plant, which has somehow found its way to the Irish and North British shores, may be said to have fixed the destiny of the great Botanist. Upon the completion of his medical studies, Brown, as is well known, was attached as ensign and assistant surgeon to a Scotch militia regiment stationed upon the western coast of Ireland.

"An inconspicuous plant with which he there became acquainted—the *Eriocaulon septangulare*,—the only European representative of an especially American order—caused his life to be diverted into the exclusive service of botany; for, accompanying a recruiting party of his regiment to London, in the summer of the year 1798, and on the road visiting his friend Dr. Withering at Edgbarton, near Birmingham, the latter caused him to introduce himself, with that plant and his researches upon it, to Dr. Dryander. This learned botanist, librarian to Sir Joseph Banks, astonished at the minuteness of the investigation, and the fullness of the conclusions derived therefrom, recommended the young military surgeon as a future master in botany; and Sir Joseph Banks from this time forward showed him a paternal kindness. He welcomed him as a regular guest at the celebrated literary breakfasts, during his five months' stay in London, and in December, 1800, proposed him to the Government as Naturalist to the naval Exploring Expedition to New Holland, under Capt. Flinders, then fitting out. Robert Brown, at this call, gave up at once the military career, came again to London at Christmas, 1800, and on the 18th of July, 1801, sailed in the 'Investigator' from Spithead to the newly discovered quarter of the globe." A. G.

2. *Fragmenta Phytographiæ Australiæ, contulit* Ferdinandus Mueller, Ph.D., M.D., Gubern. Col. Victoræ Phytologus, Hort. Bot. Melbournensis Director, etc., etc. Melbourne. Vol. I, fasc. 1—4, (pp. 96), 1858–9.—The British California in the southern hemisphere,—more enlightened and more spirited than our own,—has officially organized and promoted scientific research from the first. The colony has not only its Philosophical Institute, publishing memoirs of high character, but its Botanic Garden, Museum and Herbarium, under the charge of a Government Botanist, the able and indefatigable Dr. Mueller. Nor do they confine the energies of this officer to the Victoria Colony, but spared him to accompany, as botanist, the recent exploration by Capt. Gregory

of the northern part of the great Australian continent, where an extensive and interesting herbarium was gathered. A most enthusiastic and industrious botanist himself, Dr. Mueller awakes the interest and stimulates the activity of others; and vast collections, abounding in novelties, are rapidly accumulating in his hands. He has already published numerous scattered papers, in Germany, England and Australia. The publication now commenced has the advantage of a more convenient, connected form, and contains the characters of new genera and species, and rectifications of those published before, with important critical remarks, &c. A. G.

3. *Journal of the Proceedings of the Linnæan Society (Botany)*, Nov. 12, (1859): contains, 1st, the latter half of Prof. Henfrey's *Note on the Morphology of the Balsaminaceæ*. Balsams double [as do most blossoms] by an increase in the number of the whorls of the petals; and when merely one extra whorl of petals is developed, Prof. Henfrey finds these to alternate regularly with the five pieces which Rœper takes for the corolla; thus confirming Rœper's view (over that of Kunth) by evidence from within, of the same nature as that which *Hydrocera* normally furnishes from without. 2. *On the Arborescent Ferns of New Zealand;* by Thomas S. Ralph:—an instructive, popular account of their trunks and mode of growth. 3. *The Indian species of Utriculariæ;* by Daniel Oliver. Apparently an excellent monograph; the Indian species reduced to about two dozen. 4. *On five New Plants from Peru;* by Richard Spruce.

The botanical contributions to the Journal having much exceeded the zoological in amount, the excess is to be issued in supplemental botanical numbers. The *Supplement to Botany*, No. 1 and No. 2 have appeared, and contain the *Musci Indiæ Orientalis; an Enumeration of the Mosses of the East Indies;* by Wm. Mitten. This paper fills 171 pages, including an index to the species, and introduces some bold reforms in bryology.

4. *Synopsis Hymenophyllacearum, Monographiæ hujus ordinis Prodromus.* Auctore R. B. Van der Bosch, M. D. Leyden. pp. 79, 8vo. A separate impression from the *Nedrl Kruidk Archief*, Dec. 1858.—Dr. Van der Bosch, having in preparation a general monograph of this most elegant group of Ferns, illustrated by figures, has issued this precursory Synopsis. It contains a classified arrangement of the known species, the habitat, most important synonymy, and the characters of a few new species. The two old genera of this group—retained entire by Hooker, but divided into nineteen by Presl,—are here distributed into nine genera, with amended characters; viz:—*Cardiomanes*, Presl, *Feea*, Bory; *Neuromanes*, Trevis; *Cephalomanes*, Presl; *Trichomanes*, Smith (with about 114 known species); *Didymoglossum*, Desv.; *Leptocionium*, Presl; *Hymenoglossum*, Presl; and *Hymenophyllum* (140 species). Carrying his experience as a Bryologist into this analogous field of enquiry, our author finds available specific characters in the cellular structure of the frond. By such characters he distinguishes *Trichomanes brevisetum* from *T. speciosum*, and both from *T. radicanes*. A. G.

5. *The Botany of the Mexican Boundary. Introduction* by C. C. Parry. *Botany of the Boundary*, by John Torrey, M.D. *Cactaceæ*, by George Englemann, M.D. This forms the first half of that ponderous tome

(almost half as thick as it is wide), the second volume of the *Report on the United States and Mexican Survey* by Col. Emory, and it must be ranked as the most important publication of the kind that has ever appeared. Dr. Parry's interesting Introduction is brief. Dr. Torrey's systematic account of the general botany extends to p. 270, and is illustrated by 61 plates, most of them well-chosen as to the subject, and all admirably drawn by Riocreux, Sprague, and a few by Hochstein. Dr. Engelmann's important memoir on the *Cactacæ* occupies 78 pages of letter-press and is adorned by 75 plates of surpassing excellence. This and its counterpart, the *Cactaceæ* of the Expedition under Lieut. Whipple (of which Dr. J. M. Bigelow was the botanist), published in the fourth volume of the Explorations and Surveys for a Pacific Railroad Route, and illustrated by 24 plates, elucidate a large, peculiar, and most characteristic order of our wide south-western regions in a manner which must command universal admiration, and must assign to the author a high rank among the systematic botanists of our day. The general Botany of the same expedition, by Dr. Torrey, founded upon one of the best collections ever made in such a journey, and illustrated by 25 plates, is worthy of equal praise.

But all these memoirs are sadly marred by typographical errors. A government printing office is not well adapted for this sort of work, and proof-reading from a distance seems to be ineffectual. The zoological reports are much better printed, doubtless, because the author on the spot could insist upon a sufficient revision of his proofs, and see that his corrections were attended to. The disfigurements which we notice in these are prepense, and are caused by the depraved taste which writes the names of people with a small, instead of a capital initial letter; e. g. *edwardsii*, *clarkii*, *ordii*, *henryi*, and so on, *usque ad nauseum*. Though why they should be so decapitated when genitives after a generic name, although honored with a capital initial when they follow a specific name, passes ordinary comprehension. Consistency would seem to require uniformity like this: *Chordeiles henryi*, baird. Returning to the Botany, with which alone we are at present concerned, we remark that it would have been most convenient and acceptable to botanists to have cited the numbers of Wright's distributed collections throughout, and also, as far as possible those of Fendler, Lindheimer, and of Berlandier's posthumous distribution. A systematic catalogue of all the plants enumerated and described in these various Western Expeditions, or rather a complete catalogue of the species of the United States west of the 100th parallel of longitude, including those of the Mexican border, is now very much wanted. A. G.

6. *Catalogue of the Phænogamous and Acrogenous Plants contained in Gray's Manual of the Botany of the Northern United States, adapted for marking desiderata in exchanges of specimens, etc.* New York: Ivison & Phinney. 1859.—A help of this sort in making exchanges has often been asked for, and the enterprising publishers of Gray's Manual have responded to the demand by publishing, at a low price, this neat Catalogue, for which good office they deserve the best thanks of our scattered botanists. The species are numbered consecutively, from No. 1, *Atragene Americana* to 2421, *Azolla Caroliniana*. The list, in double columns, fills thirty-two pages of the same size as those of the Manual

itself. A cent stamp will pay the postage of the pamphlet to any part of the United States; and the sender has only to indicate to his distant correspondent, by marking or by copying the numbers, the species which he desires to receive or is able to furnish. Moreover, the names of the orders, which are printed in bold type, and even those of the genera, may serve another useful purpose: they may be cut out and used for labels in the herbarium. A. G.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *The Thirteenth Meeting of the American Association for the Advancement of Science* was held August 3–9, 1859, at the City Hall in Springfield, Massachusetts.—The Springfield meeting of the American Association passed off with decided success; the greatest harmony and good feeling prevailed. A large gathering of members from all parts of the United States and Canada and foreign countries enjoyed the graceful hospitalities of one of the most beautiful cities in New England. The number of members in attendance was estimated to be about five hundred. The weather throughout was as fine as possible, and the excursion to Amherst College under the escort of the venerable and distinguished Dr. Hitchcock, was an occasion long to be remembered as one of the golden days of life. Members seemed lost in admiration of the romantic loveliness of the scenery surrounding the College, and in the unexpected extent, richness, and high condition of the scientific collections, unequalled certainly by those of any other college in the United States. Here Dr. Hitchcock has built up a lasting monument of his original labors in the curious department of foot-marks on the Connecticut sandstone. This vast collection, vast both in the numbers and magnitude of its specimens, is now preserved in "Appleton Hall," a new building erected specially for its accommodation, and on the ground floor of which these curious records of lost races once denizens of this lovely valley are spread out to the inspection of visitors. No one can form an adequate notion of the interest of these remarkable collections without a personal inspection.

Whatever the *Black stone* of Mecca may prove to be, meteorite or porphyry, the scientific pilgrim to Amherst will be rewarded by an inspection of the largest and most important collection of meteoric specimens in the world, excepting that of the Imperial Museum of Vienna. By the untiring exertions of Prof. Shepard, 124 meteoric discharges are here represented, in choice and unblemished specimens. The Vienna cabinet is stated in Mr. Haidinger's paper of Jan. 7, 1859, to contain 137 localities.

The mineralogical collection of Prof. Shepard at Amherst is worthy of most particular notice. In the richness and splendor of its selections, the mineral species are nowhere in America and seldom anywhere so well represented. Choice specimens seem to have come to this celebrated collector's hands like the fabled fish of the wierd fisherman. Whatever was most rare or choice from any locality appears to have found no rest until it was safely placed on his shelves.

No wonder then that amid such surroundings and with beauty and festive speech at the hospitable tables covered by the fair hands of Amherst ladies, the Association was beguiled to view the glories of a midsummer sunset over the picturesque ranges of the Northampton hills, or

that they returned to Springfield late in the evening full of the praises of the day and its rich entertainments.

We append a list of the officers of the Springfield meeting, and also of the papers registered.

Officers of the Association, Springfield meeting.—President, Professor Stephen Alexander.—*Vice President*, Prof. Edward Hitchcock.—*Permanent Secretary*, Jos. Lovering.—*General Secretary*, Wm. Chauvenet.—*Standing Committee*, Professors Stephen Alexander, Jeffries Wyman, William Chauvenet, Joseph Lovering, Edward Hitchcock, John E. Holbrook, A. L. Elwyn, Alexis Caswell, W. M. Gillespie, Benjamin Peirce, A. D. Bache, B. Silliman, Jr., Joseph Leconte, Wolcott Gibbs, J. W. Foster, Esq.—*Local Committee*, Hon. George Bliss, *Chairman*.—Dr. George A. Otis, Jr., *Secretary*. R. A. Chapman, Esq., Rev. Francis Tiffany, George M. Atwater, Capt. James Barnes, Samuel Bowles, Ansel Phelps, Jr., Esq., Hon. C. C. Chaffee, Chester W. Chapin, Col. J. M. Thompson, George Walker, Esq., John L. King, Gen. James S. Whitney, Ethan S. Chapin, Josiah Hooker, Esq., A. D. Briggs.—*City Committee*, Mayor William B. Calhoun; Aldermen Roger S. Moore and Horace Smith; Councilmen Gurdon C. Judson, Reuben T. Safford, Joshua M. Harrington, Walter North.

*List of papers registered for presentation to the Association.**

1. On the Origin of the Azoic Rocks of Michigan and Wisconsin; by Charles Whittlesey.
2. On the Drift Cavities, or "Potash Kettles" of Wisconsin; by C. Whittlesey.
3. General Account of the Results of the Discussion of the Declinometer Observations made at Girard College, Philadelphia, between the years 1840 and 1845, with special reference to the Eleven Years' Period; by A. D. Bache.
4. Distribution of Temperature in the Florida Channel and Straits; by A. D. Bache.
5. Comparison of the Amount and Frequency of Rain with different Winds on the Western Coast of the United States; by A. D. Bache.
6. Abstract of the principal results of the Observations of Temperature at Van Rensselaer Harbor, North Greenland, made by the second Grinnel Expedition under command of Dr. E. K. Kane, U. S. N., during the years 1853-4-5; presented by A. D. Bache, from a reduction and discussion by Charles A. Schott, assistant in the Coast Survey.
7. Abstract of the principal results of the Discussion of the Observations for the Direction and Force of the Wind at Van Rensselaer Harbor, North Greenland, made by the second Grinnel Expedition, under the command of Dr. E. K. Kane, U. S. N., in 1853-4-5; presented by A. D. Bache, from a reduction and discussion by Charles A. Schott, assistant in the U. S. Coast Survey.
8. Abstract of the principal results of the Discussion of the Observations for Atmospheric Pressure at Van Rensselaer Harbor, North Greenland, made by the second Grinnel Expedition under command of Dr. E. K. Kane, U. S. N., during the years 1853-4-5; presented by A. D. Bache, from a reduction and discussion by Charles A. Schott, assistant in the U. S. Coast Survey.
9. On the Occurrence of Pot Holes, (or pot-shaped excavations, caused by the gyration of pebbles,) formed by the Drift Agency; by Oliver Marcy.
10. On the marks of Ancient Glaciers, on the Green Mountain Range in Massachusetts and Vermont; by Charles H. Hitchcock.
11. Lake and Pond Ramparts in Vermont; by Charles H. Hitchcock.

* The asterisk prefixed indicate papers not read, and should probably be attached to some others not certainly known to the Editors.

12. On the so-called Talcose schist of Vermont; by Charles H. Hitchcock.
13. Dykes of Trachyte and Conglomerate in Shelburne, Vt.; by C. H. Hitchcock.
14. Conglomerate Syenite Porphyry and Granite in Vermont; by Charles H. Hitchcock.
*15. On the Circulation of the Ocean; by Charles Wilkes.
16. Some Observations on Ozone; by John Brocklesby.
17. Contributions on the subject of Frozen Wells and Cold Springs; by John Brocklesby.
18. On cutting the Threads of Male and Female Screws, so that they shall commence and terminate at any desired points with precise uniformity and correspondence; by Cyrus Buckland.
*19. A method for discharging the Leyden Jar, by employing an Imperfect Conductor; by C. B. Chapman.
20. Origin, Direction, and Progress of Storms in the United States, east of the Rocky Mountains; by Chester Dewey.
21. On the Mass of the Moon; by Stephen Alexander.
22. A question as to the Earth's Dimensions and Metre; by Stephen Alexander.
23. A brief note on Comets; by Stephen Alexander.
24. On the Harmonies and the Ancient History of the Solar System; by Stephen Alexander.
25. On the Common Origin of the Asteroids, and also of some of the Comets of short period; by Stephen Alexander.
26. On the Causes of the Variation of Temperature of the Seasons; by G. W. Burnap.
27. On the Theory of the Comet's Tail; by Benjamin Peirce.
28. On the History of the Investigation of the Physical Constitution of Comets; by Benjamin Peirce.
29. On the Personal Peculiarities of Astronomical Observers; by Benj. Peirce.
30. On the Possible Causes of the observed Geological Changes in the Earth's Temperature; by Benjamin Peirce.
31. On the Secular Perturbation of four of the Asteroids; by Simon Newcomb.
32. On the Mathematical Theory of Music; by T. H. Safford.
33. On the Determination of a Comet's Orbit; by T. H. Safford.
34. On a new method of investigating Plane Curves, with its application to Evolutes and Caustics; by William Watson.
35. On Meteorology; by Joseph Henry.
36. An Analysis of the Laws which determine the Action of the Centrifugal Governor; by Charles J. Porter.
37. The Indian Mode of bestowing and changing Names; by L. H. Morgan.
38. Researches on the Platinum Metals; by Wolcott Gibbs.
39. A Systematic Reference Catalogue of all the described North American Lepidoptera; by John G. Morris.
40. The complete Semicircle of the Zodiacal Light, as seen at night recently by various observers; by George Jones.
41. The occasional luminousness of the Atmosphere at night, as observed on the summit of the Andes; by George Jones.
42. On the European Storm of Dec. 25, 1836; by Elias Loomis.
43. On the alleged Lunar Origin of Aerolites; by B. A. Gould, Jr.
44. On the occurrence of bones and teeth in the lead-bearing crevices of the Northwest; by J. D. Whitney.
45. On certain Curves treated by new Coördinates; by Thomas Hill.
46. On the Scope and Method of Linguistic Science; by W. D. Whitney.
47. Certain Arts which distinguish Nations of the Eastern World from the Aborigines of this Western Continent; by J. H. Gibbon.
48. Is Indian Corn (*Zea Mays*) a native of three continents, like Cotton and Tobacco? by J. H. Gibbon.
49. Winds of the Southern Hemisphere; by James H. Coffin.
50. On the Hindu Astronomy; by W. D. Whitney.
51. On the Lasso-Cells of Polypi and Acalephæ; by H. J. Clark.
52. On the Facetted Eyes of Acalephæ, especially of *Aurelia flavidula*; by H. J. Clark.

53. On apparent equivocal Generation; by H. J. Clark.

*54. On a supposed Meteorite of a new Chemical Constitution from North Carolina; by C. U. Shepard.

*55. On an Examination of the Matter of a supposed Shooting Star that fell on the eve of November 16th, 1857, at Charleston, S. C.; by C. U. Shepard.

56. Vibrations in the Water-fall at Holyoke, Mass.; by E. S. Snell.

57. System of Consanguinity of the Red Race, and its relations to Ethnology; by Lewis H. Morgan.

58. On a Frozen Deposit of modified Drift in Brandon, Vermont; by Edward Hitchcock.

59. On the Conglomerate near Newport, R. I., with elongated pebbles and transverse joints; by Edward Hitchcock.

60. On a Deposit of Fossiliferous Limestone beneath Granite and Mica slate in Derby, Vermont; by Edward Hitchcock.

61. An attempt to prove that the younger Metamorphic Rocks have been in a plastic or semi-plastic state since their original consolidation; by E. Hitchcock.

62. On the Amount and Proofs of Erosion in Vermont, with special reference to Peaks of protrusive rocks; by Edward Hitchcock.

63. Recent Discoveries in the Devonian and Carboniferous Flora of British America; by J. W. Dawson.

64. The means of preventing the Alteration of Metallic Surfaces employed to close and break a voltaic circuit; by F. A. P. Barnard.

65. On the sudden Disappearance of the Ice of our Northern Lakes; by J. G. Totten.

66. On Nitride of Zirconium; by J. W. Mallet.

67. On the Atomic Weight of Lithium; by J. W. Mallet.

68. On Osmious Acid, and the position of Osmium among the Elements; by J. W. Mallet.

69. On the Vertical Planes in Bituminous and other Coals; by E. B. Andrews.

70. On the Terraces along the Rivers in Southern Ohio; by E. B. Andrews.

*71. On the Zoomorphic Sandstone of the Connecticut Basin; by Joseph Barratt.

*72. On the Discovery of a Creature (*Kamdactylus sub-humanus*), the Antetype of Man; by Joseph Barratt.

73. Ornithichnites; by Roswell Field.

*74. On the Geometrical Construction of Curves of degrees higher than the second, having given multiple points; by H. A. Newton.

75. The Correlation of Physical, Chemical and Vital Forces, and the Conservation of Force in Vital Phenomena; by Joseph Leconte.

76. On the Formation of Continents and Oceans; by Joseph Leconte.

77. Observations on the Geology of the Rocky Mountains in the vicinity of Santa Fe, New Mexico; by William P. Blake.

78. Physical Constitution of Comets; by W. A. Norton.

79. On the alleged occurrence of Sand in Maple Sugar; by E. N. Horsford.

80. On the Source of Carbonate of Lime in Organic Structures occurring in Seawater; by E. N. Horsford.

81. On some recent Determinations of the Carbonic Acid in the Waters of the Congress Springs of Saratoga; by William E. Hughes, presented by E. N. Horsford.

*82. Some experiments made at the Lawrence Scientific School, on the heating powers of luminous and non-luminous Flames; by G. A. Gould, presented by E. N. Horsford.

*83. On the Prevention of Fermentation in the Juices of Fruits, by means of Sulphite of Lime; by E. N. Horsford.

84. Theoretical Explanation of the similarity between the Flora of Northeastern Asia, and that of Eastern North America; by Asa Gray.

85. Note on the Discharge of Atmospheric Electricity through Gas Mains; by Benjamin Silliman, Jr.

*86. On the application of Electric Conductors to Buildings; by L. F. Locke.

87. Remarks on the Restored Skeleton of the Fossil Whale of Charlotte, Vt.; by Edward Hitchcock, Jr.

88. On some applications of the principle of Relative Motion to the determination of the Areas of Closed Curves; by George Eastwood.

89. On the use of a Transit-Circle as a substitute for the Zenith Telescope in the determination of Latitude; by C. S. Lyman.
90. Instruments for measuring the Depth of the Ocean; by W. P. Trowbridge.
91. On the Stratigraphical Position of the Sandstone of the Connecticut Valley; by J. D. Whitney.
92. On a remarkable Vein of Gold in the bed of the Chestatee river, Georgia; by W. P. Blake.
93. The Placer Gold Mines of Georgia, and the introduction of improved methods of working them; by W. P. Blake.
94. Remarks on the Minerals and Ancient Mines of the Cherokee Valley River, North Carolina; by W. P. Blake.
95. Contribution to the History of the Laurentian Limestones; by W. E. Logan.
96. On "Anhydrous Fermentation;" by L. F. Locke.
97. On some Reactions of the Salts of Lime and Magnesia; by T. S. Hunt.
98. On the Paradox of the Coexistence of Excessive Production and Excessive Population; by Clinton Roosevelt.
99. On the Formation of Gypsum and Magnesian Rocks; by T. S. Hunt.
100. On the Origin and Formation of Silicious Rocks; by T. S. Hunt.
101. The Relations of the Upper Carboniferous Rocks of Illinois to the older members of the Palæozoic System; by J. H. McChesney.
102. Remarks on the Discovery of a Terrestrial Flora in the Mountain Limestone of Illinois; by A. H. Worthen.
103. On the Composition of Pectolite; by J. D. Whitney.
104. On Magnetizing Locomotive Wheels by Curved Helices, and the Experimental Results; by Edward W. Serrell.
105. Vital Observations and Statistics as Data for the Formation of Natural Life-Tables; by E. B. Elliott.
106. Experiments on Induction-Time in Electro-magnets in Telegraph Lines; by A. D. Bache and J. E. Hilgard.
107. On Certain Phenomena of the Great Dismal Swamp in Virginia and North Carolina; by Nathan B. Webster.
108. The Causes of Steam-boiler Explosions; by James Hyatt.

The officers of the Association for 1860 are: President, Isaac Lea, of Philadelphia; Vice President, B. A. Gould, Cambridge, Mass.; General Secretary, Joseph LeConte, of Columbia, S. C.; Treasurer, A. L. Elwyn, of Philadelphia.

The next meeting will be held at Newport, R. I., on the first of August, 1860. The warm waters of that shore will offer a rich treat to the naturalists who will unquestionably assemble at Newport in unwonted numbers.

The address of the retiring president, Prof. Alexis Caswell of Brown University, after paying a deserved tribute to the memory of deceased members, was a sketch of American progress in his favorite science of Astronomy. It will be published in the Transactions of the Association.

Among the attractions already visible for the Newport meeting will be—by appointment of the Association—a discourse by Prof. Joseph Henry, commemorative of the life and scientific labors of Dr. Robert Hare; and an address by A. D. Bache on the Gulf Stream. It is equally interesting and appropriate that the labors of his great grandson should have contributed so signally to enlarge our knowledge of this wonderful river of the sea, which Dr. Franklin was the first to bring to the general notice of the scientific world. Dr. Jos. Leidy was also requested to address the Association at Newport upon the extinct Reptilia and Mammalia of North America.

2. *Scientific versus Practical Instruction.*—The following testimony of Liebig as to his famous school at Giessen, is worth considering in these days of schools of practical science.

"The technical part of an industrial pursuit can be *learned:* principles alone can be *taught.* To learn the trade of husbandry the agriculturist must serve an apprenticeship to it; to inform his mind in the principles of the science he must frequent a school specially devoted to this object. It is impossible to combine the two; the only practicable way is to take them up successively. I formerly conducted at Giessen a school for practical chemistry, analysis, and other branches connected therewith, and thirty years' experience has taught me that nothing is to be gained by the combination of theoretical with practical instruction. It is only after having gone through a complete course of theoretical instruction in the lecture-hall that the student can with advantage enter upon the practical part of chemistry. He must bring with him into the laboratory a thorough knowledge of the principles of the science, or he cannot possibly understand the practical operations. If he is ignorant of these principles, he has no business in the laboratory. In all industrial pursuits connected with the natural sciences, in fact, in all pursuits not simply dependent on manual dexterity, the development of the intellectual faculties by what may be termed school learning, constitutes the basis and chief condition of progress and of every improvement. A young man with a mind well stored with solid scientific acquirements will, without difficulty or effort, master the technical part of an industrial pursuit; whereas in general, an individual who is thoroughly master of the technical part may be altogether incapable of seizing upon any new fact that has not previously presented itself to him, or of comprehending a scientific principle and its application."—*Liebig, Letters on Modern Agriculture, edited by John Blyth, M.D.*

3. *Dr. Newberry's late Explorations in New Mexico—he shows Marcou's so-called Jurassic to be Cretaceous.*—Advices have been received from Dr. Newberry at Santa Fé, N. Mexico, as late as July 18th, in letters to Mr. Meek. Dr. N., following the Santa Fé road from Independence, Mo., to near Burlingame, Kansas, saw nothing but rocks of the upper Coal measures, but near Burlingame, on the banks of Dragon creek, he found the first Permian forms [the dip in all this region is N.W.] From Wellington to Cottonwood and Turkey creek the Permian was constantly found in the hill-tops, but the valleys were excavated down to the Carboniferous. The Permian was a light cream-colored Magnesian Limestone. From the Little Arkansas to Walnut creek the surface rocks were Red, Yellow and White Marls and Gypsum, so characteristic of the Llano Estacado and the country west of the Rio Grande. There were no fossils. These are the beds seen by Meek and Hayden and described by them as between the lower Cretaceous and the Permian in Kansas, some 35 to 40 miles farther to the northeast, and which rocks they state in their paper may be either Jurassic or Triassic—but they (like Dr. Newberry) discovered no fossils in them.

On the banks of Walnut creek, a tributary of the Arkansas—a little farther west, Dr. Newberry saw the same red or brown sandstone from which Messrs. Meek and Hayden collected the fossil leaves on Smoky Hill

river, some 40 or 50 miles farther to the northeast, and also in Nebraska at the Blackbird Hills. In this sandstone and in a gray clay beneath it, he also has found some of the same "leaves of dicotyledonous trees—Willows, &c., precisely as at Smoky Hill, Blackbird Hills and in New Jersey." These leaves Dr. Newberry pronounces the same which mark the base of the Cretaceous in New Jersey, Nebraska and Kansas. These are the leaves declared by Prof. Heer and Mr. Marcou to be *Miocene!*

The Cretaceous beds at this point were not seen by Dr. Newberry overlying the sandstone, but on the Canadian, further southwest, as we might expect from the dip, he found this *same sandstone overlaid by the same Cretaceous seen by Meek and Hayden surmounting it in Nebraska.* In these Cretaceous beds,—a whitish marly limestone and shale (Nos. 2 and 3 of the Nebraska Section of Meek and Hayden, the Sandstone being No. 1,)—he found *Inoceramus problematicus*, a well known Cretaceous species (so in England and various parts of Europe,) as well as in No. 3 of the Nebraska Section,—associated with *Ammonites New-Mexicana*, *Gryphæa Pitcheri* (*G. dilatata*, var. *Tucumcarii* of Marcou). Thus we have the same stone which Mr. Marcou and Prof. Heer would make *Miocene, overlaid* by beds containing not only well known and admitted Cretaceous fossils, but along with these the very *Gryphæa* relied upon by Mr. Marcou for the establishment of the existence of the *Jurassic.* So if Mr. Marcou and Prof. Heer are right, the Miocene proves to be older than the Cretaceous and the Jurassic! and the unfortunate American geologists find to their confusion that the roof of their geological edifice was constructed before the foundation was laid.

Dr. Newberry states also, "at Galisteo I found upper and lower Cretaceous rocks beautifully exposed, and in the *lower Cretaceous Sandstone* (Jurassic of Marcou) *dicotyledonous leaves.*" "The [true] Jurassic may be in New Mexico," he continues, "but we have not yet detected it—Marcou's Jurassic is certainly not so."

The facts elicited by Dr. N. seem however to sustain the Trias in New Mexico. Writing from Abiquia (near Santa Fé), N. Mexico, he says: "Here in the red gypsum-bearing marls—the 'Gypsum formation' of Blake, and the 'Marl Seams' of Dr. N.'s former report he finds extensive deposits of copper—copper schists and copper conglomerate, precisely as the copper schists of Europe." The red gypsum-bearing rocks here referred to as embracing the copper schists are probably the same seen by Meek and Hayden in Kansas between the Permian and the Lower Cretaceous, and which they were disposed to refer to the Jurassic or Triassic.

The most important evidence however, of the age of these deposits, is in the occurrence in them of Cycadaceous plants—*Zamites*, *Pterophyllum*, &c., which are, in Dr. N.'s opinion, similar to those of the Keuper (Upper Trias) of Europe; but he reserves a positive assertion on this point until he can compare his New-Mexican forms more carefully with the European species than is possible in the field.

Dr. Newberry's route lay from Abiquia, the day after his latest date (July 18th) towards the country near the mouths of the San Juan, which, from all accounts, is a paradise for the geologist, but very much the reverse for other people. He hopes to exhibit his interesting collections to his geological friends in the United States by the end of October.

4. *Meteor of August* 11, 1859.—On the morning of the 11th of August, at 7 o'clock and 20 minutes, or thereabouts, thermometer 73° F., air still and without clouds, two violent and successive explosions or reports (one witness, Mrs. Ball, says there were three,) were heard over a district of country, extending in an east and west line, from Blandford, in Hampden county, Massachusetts, to some ten miles west of the cities of Troy and Albany on the Hudson—a distance of about 100 miles;—and in a north and south line from Bennington, Vt., to Columbia Co., N. Y., a distance of about 80 miles.* The noise, which has been compared by some, to two successive, sharp and heavy peals of thunder, and by others, to the report occasioned by the explosion of a steam-boiler, or powder-mill, was accompanied by very distinct and prolonged echoes, and appears to have been noticed most sensible, and to nearly an equal degree, in Troy, Greenbush, Lansingburg, Waterford, Grafton, and New Lebanon, in N. Y., at Bennington in Vermont, and in the vicinity of Pittsfield, Mass. At Troy, the concussion was so great that houses were shaken, and people walking in the streets were conscious of a vibration of the earth. At Schaghticoke, N. Y., and Bennington, Vt., where powder-mills are in operation, the report was referred by the citizens to explosions at the works. At Schaghticoke, when the managers of the powder-works ascertained that no explosion of mills had taken place either in their own town or in Bennington, they at once concluded that a train of waggons despatched from their works for Troy, a few hours before, with powder had been blown up, and messengers were sent with haste in pursuit of them. At Eagle Bridge, on the Troy and Bennington railroad, the concussion was forcible enough to jar the windows and shake the seats in a train of cars in motion. At Schodack, on the Springfield and Albany railroad, men who were at work in the fields heard the report and felt the shock with great distinctness, and at Greenbush, a large number of people rushed to the docks, expecting that a steamboat had burst its boiler.

As to the cause of the phenomenon;—a great abundance of concurrent testimony, seems to prove, that it was due to the explosion of an immense meteor at a considerable distance above the surface of the earth. This evidence, so far as we have been able to collect it is, as follows:—

John P. Ball, County Clerk of Rensselaer Co., N. Y., in a letter to the editor of the Troy Times, states: "that as he was standing in his door-yard, just after breakfast, he observed a bright body in the air, descending very rapidly to the ground in a northwesterly direction. When apparently about a half a mile above the earth, it disappeared, and in a moment or more he heard the explosion. It was very loud and resembled thunder. He had previously called his family to view the meteor, and they all observed the light and heard the explosion. Mrs. Ball insists that there were three separate explosions—one much louder than the others—and in support of her statement, Mr. B. says he saw three distinct clouds of smoke in the track of the meteor, which appeared to be a mile or more apart. The smoke was visible for some time, but was finally lost to sight. The meteor appeared to be at a distance of about twenty miles from Mr. Ball's residence."

* The limits, as here given, are based upon positive information; they may, however, possibly have been much more extensive.

Ezra Turner and son, of North Schaghticoke, N. Y., three miles north of Mr. Ball's residence in Grafton, observed the meteor distinctly, and heard the explosion.

At New Lebanon, N. Y., it was seen by two members of the Shaker community to pass over their town in the direction of Troy, and was apparently as large as a "flour barrel."

At Hoossic, N. Y., it was also observed, together with the cloud of smoke that followed the explosion. A lad living in the easterly limits of the city of Troy, N. Y., saw a ball of fire in the air, and called his family to look at it. As he did so the extraordinary report was heard, and those who looked in the direction he indicated, saw a small but dense cloud of smoke.

Under date of Aug. 13th, 1859, J. R. Simmons of Berlin, N. Y., writes to the editor of the Troy Whig, as follows:—"I was standing in front of my house on Thursday morning, the 11th inst., at 7 o'clock and 20 minutes,—there being a cloudless sky or very nearly so,—when my attention was suddenly attracted upwards. I saw a meteor of gigantic size, passing between the perpendicular and the altitude of 65°, towards the southwest, in a horizontal line, with great velocity, remaining in sight several seconds, and leaving trails of smoke at intervals. The color was red, like lights thrown from a roman candle, and had connected with it all the rainbow hues. While it was passing in sight, I remarked to the Rev. J. D. Rogers and my family, 'there's a rocket;' they did not get to the door before it had passed out of sight, leaving nothing but the trails of smoke for them to see. While we were looking at these, I remarked to Mr. R., that I had never seen a meteor previous to this, without hearing sound produced like a fireball in its flight through the air, or like the report of a fowling gun when discharged. After the lapse of five minutes we all heard the [qu. *three?* Eds.] heavy peals, more terrible than thunder, jarring the earth as well as the atmosphere. I have heard so many conjectures in relation to what produced the terrific report, and most of them so remote from the real cause, that I have given you a correct description of the whole scene that has caused so many remarks."

At Livingston, Columbia Co., N. Y., the meteor was observed in the north, "*with strips of apparent smoke, and a long rumbling sound.*"

Under date of August 18th, 1859, Emory F. Strong of South Manchester, Connecticut, writes to the editors of the Hartford Courant as follows:—"About twenty minutes before eight o'clock on the morning of the 11th, I was standing with a friend in a position facing the northern horizon, when our attention was attracted by an unusual appearance in the heavens—a luminous body, equal to the sun in brightness, was seen about ten degrees west of the meridian, and passing rapidly in a westerly direction; when within apparently twenty degrees of the horizon it disappeared for an instant and then on reappearing seemed to explode. Its last appearance was not unlike that of a large sky-rocket in the act of explosion. We listened for the report but heard none. The sun was shining brightly at the time, which would have rendered the phenomenon invisible to all except those whose attention for the moment happened to be directed to that particular portion of the heavens."

A correspondent of the N. Y. Evening Post, writing from New Lebanon, N. Y., gives the following account of this phenomenon as observed

in that vicinity:—"About 7 o'clock on that morning as I was about to leave my bed chamber, I was startled by two distinct and very heavy explosions, so that I immediately ran to the window and looked over toward the Shaker village hill, where I knew they were blasting stones to build the great dam in that village, but could see no smoke at all, the sky being clear and the weather beautiful. The noise was so startling as to call the attention of every one about the premises, and various persons in our house (a large farm house) went out of doors, and others to the window, to see what was the matter. The *house trembled* so as to be noticed by all of us—a family of over twenty people, and more than half were in the house at the time.

"We supposed some powder mill had exploded, but heard during the day that two of the 'Shakers,' Messrs. Calvert and Chase, (two miles from here,) who were out in the field, had their attention drawn to a bright light in the sky, when they saw a meteor, which exploded apparently in the vicinity of Pittstown, and immediately the great report followed. They were looking north, while my window looked south, but I might not have seen the meteor if I had looked north, as the two 'Shakers' were on a high hill, while I was in a valley. [This fully confirms Mr. Ball's account].

"My brother, with three others of our family, was riding in a carriage, on his way to Canaan to meet the cars, at the time of the explosion, and the noise was so great as to excite remarks from all in the carriage, and to make both the horses jump as though frightened. The noise was heard at all the neighboring villages, and resounded through the valleys and hills like very heavy thunder. It was heard at 'Columbia Hall,' at Lebanon Springs, one and a half miles from here, but not so distinctly as we heard it, as the explosion occurred north of us, and that hotel stands on the south side of a high hill."

From Morristown, Lamoille county, Vermont, twenty-five miles north of Montpelier, Mr. J. M. Chatterton writes, that the meteor was seen at the same time as noticed elsewhere, by himself and others. "The sun was shining brightly at the time, and its course was towards the south."

"A Subscriber" writes to the Boston Journal from "Copperas Hill," Strafford, Vt., confirming the accounts from Troy. He says:—"The same phenomenon was witnessed from this place by two gentlemen who were making investigations in the extensive mines of copper, iron, &c., to be found here. At the same hour above mentioned, their attention was suddenly attracted by a very brilliant object descending in a southwesterly direction, and resembling very much one portion of what is called golden rain in a rocket, only many times larger, and followed by a long train of light. Although the sun was shining brightly, still so intense was the brilliancy of this meteor, or whatever it might have been, that it had the appearance of not being over half a mile off, and we were fully expecting to feel the effects of some great explosion; but its distance was so much greater than we had apprehended, that no shock was experienced."

The Albany Evening Journal of Aug. 20th has the following item:—"Garritt Vanderpool, a well-known and highly respected farmer, lives seven miles from this city, and one mile west of the Bethlehem church. When at work in his barn, on the morning of the mysterious commotion heretofore referred to, and about two minutes after the noise which had attracted his attention had ceased, he heard what sounded like a small

stone thrown against the side of his carriage-house. On looking up, he saw the object fall, and at once picked it up. It is about the size of a pigeon's egg, broken through the centre; and is partially covered with a black substance. Mr. V. says there is no stone on his farm like it, and is fully persuaded that it is a part of the exploded meteor. Others also think so. It will be examined by competent judges, and the result properly announced."

The above seem conclusively to establish the fact that a meteor of great size passed into our atmosphere on the morning of the 11th of August and exploded with great violence, throwing down stones to the earth. It would even seem possible, from a comparison of these facts, to deduce its mass, velocity and apparent motion.

In this connexion we would recall the familiar history of the remarkable meteor which exploded over Weston, Conn., on the morning of December 14th, 1807, as described by Profs. Silliman and Kingsley.* In that case there were three distinct and violent explosions, each followed by a discharge of meteoric stones, specimens of which from each locality were subsequently obtained. Let us hope that a diligent search for the relics of the Troy meteor will be in like manner rewarded, and the results duly reported.—[D. A. Wells, Esq., of Troy, N. Y., has kindly sent us most of these facts.—Eds.]

Bibliographical Announcements.

5. *Address at the Anniversary Meeting of the Royal Geographical Society* (23d May, 1859); by Sir Roderick Impey Murchison, G.C.St.S., D.C.L., F.R.S., President. London, Cowles & Sons. 8vo, pp. 132.—This Address is full of interesting notices of the lives and services of illustrious members of the Geographical Society deceased during the year.

6. *Elements of Mechanics for the use of Colleges and Academies;* by William G. Peck, Adjunct Professor of Mathematics, Columbia College. New York. A. S. Barnes & Burr. 12mo. pp. 338. 1859.—This work embraces all the important propositions of elementary mechanics, arranged in logical order and each rigidly demonstrated. It fills an important hiatus in our elementary works and in the hands of a good teacher will be highly esteemed.

7. *Annual Report of the Director General of the Geological Survey of the United Kingdom; the Museum of Practical Geology, &c.* 24 pp. 8vo, with 4 progress maps.—This is the annual report showing the progress made in the several important scientific trusts comprised in the Jermyn St. establishment now under the general direction of Sir R. I. Murchison.

8. *Experimental Researches relative to Corroval and Vao; two new varieties of Woorara, the South American Arrow-Poison;* by William A. Hammond, M.D., Assist. Surgeon U. S. Army and S. Weir Mitchell, M.D., Philadelphia. Read before the Academy of Nat. Sci. Philad., May 16, 1859. [*Brochure*, Extracted from the Am. Jour. Med. Sci., July, 1859.] pp. 48.

9. *Astronomical and Meteorological Observations made at the Radcliffe Observatory, Oxford, (Eng.)* in the year 1857, under the superintendence of Manuel J. Johnson, M.A., Radcliffe Observer. Vol. xviii. Published by order of the Radcliffe Trustees. Oxford, J. and J. Parker. 1859. 8vo. pp. 255 Astronomical, 132 Meteorological. 7 plates.

* Memoirs Connecticut Academy of Arts and Sciences, vol. i, pp. 141 (1810.)

10. FOWNES: *A manual of Chemistry, &c.*, edited from the 7th London edition by Dr. ROBERT BRIDGES. Philadelphia, 1859.—The simple announcement of a new edition of this favorite manual is all that is needed to bring it to the notice of students and teachers.

11. *The American Gas Light Journal*, the representative of Light, Water, and Public Health. J. C. Murray & Co., 40 Wall st., N. York. 4to, monthly.

DAVID DALE OWEN: First Report of a Geological Reconnoissance of the Northern Counties of Arkansas, made during 1857 and 1858, by D. D. Owen, Principal Geologist, assisted by W. Elderhoist, Chem. Assistant, and Edward T. Cox, Assistant Geologist. 8vo. pp. 256. *Little Rock*, 1859.

Books in Press.

A Manual of Spherical and Practical Astronomy, embracing Nautical Astronomy, and the theory and use of fixed and portable Astronomical Instruments: amply illustrated by engravings on wood and steel. By Prof. WILLIAM CHAUVENET, of the United States Naval Academy. In two royal octavo volumes. Price $7.50.

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